Quality Assurance Project Plan

FIELD INVESTIGATIONS TO HELP SUPPORT THE ASSESSMENT OF BACKGROUND CONCENTRATIONS FOR URANIUM (U) AT THE HOMESTAKE MINING COMPANY, SUPERFUND SITE NEAR MILAN, NEW MEXICO

July 26, 2016

Prepared for the:
United States Environmental Protection Agency Superfund Division Region 6
Dallas, Texas

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A1 Approval Page

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A2 Table of Contents

Abbreviations and Acronyms

ASTM	American Society of Testing and Materials
BG	borehole geophysics lead
C	degrees Celsius
CAR	corrective action report
Cl	chloride
COC	chain-of-custody
COCs	contaminants of concern
DI	deionized water
DO	dissolved oxygen
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
ft	feet
gal/dy/ft	gallons per day per foot
GPS	global positioning system
HASP	Health and Safety Plan
LOD	limit of detection
LOQ	limit of quantitation
LTP	large waste tailing pile
MCL	maximum contaminant level
MDL	method detection limit
µg/L	micrograms per liter
mg/L	milligrams per liter
Mo	molybdenum
NCR	nonconformance report
NMED	New Mexico Environment Department
NO_3	nitrate
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NSPS	nylon-screen passive samplers
NWIS	National Water Information System
OSHA	Occupational Safety and Health Administration
PC	project chief
PM	project manager
QA	quality assurance
QAO	quality assurance officer
QAPP	quality assurance project plan
QC	quality control
RPD	relative percent difference
RPM	remedial project manager
Se	selenium
Site	Homestake Mill Site
STP	small tailings pile

TDS	total dissolved solids
Th	thorium
U	uranium
USGS-TL	U.S. Geological Survey- technical liaison
USGS	U.S. Geological Survey- water mission

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A4 Project/Task Organization

U.S. Environmental Protection Agency (EPA) Remedial Project Manager (RPM) Sairam Appaji: The RPM, EPA Region 6 is responsible for ensuring that tasks and other requirements in the inter-agency agreement are executed in a timely manner and in accordance with the quality assurance/quality control requirements in the system as defined by the work plan, inter-agency agreement, and in the quality assurance project plan (QAPP); and for coordinating necessary conference calls, meetings, and related project activities with the U.S Geological Survey Water Mission (USGS) and other interested parties.

Water Science Center Director-Bob Joseph: The director is responsible for ensuring the actions and products of his or her staff produce the desired results such as quality, timeliness, cost effectiveness, and relevance to meeting cooperator needs.

Project Manager (PM) - Kent Becher: The PM provides leadership to the field team with responsibility for assuring that the project stays focused on the cooperator's needs and expectations and that all work is integrated and done in accordance with the approved work plan. The PM assures that the cooperator's interests are properly represented within USGS and serves as the primary point of contact between EPA and the USGS. Specifically, the PM keeps the USGS management apprised of the cooperator's expectations and the status of the project's progress, assists in early identification and resolution of problems, and identifies where additional resources and effort are required to meet the USGS commitments established in the project work plan. The PM has specific project responsibility for ensuring all required quality control (QC) requirements are implemented and that the resulting products are technically sound.

USGS Project Chief (PC) – Phil Harte: The PC will be responsible for making sure the work outlined in this work plan is conducted. The PC is the technical lead for this project and will advise the PM and staff in regards to recommended technical procedures. The PC will make sure that all of supplies and equipment are onsite and ready for use for groundwater sampling. The PC will keep the PM informed on progress and any problems that may occur.

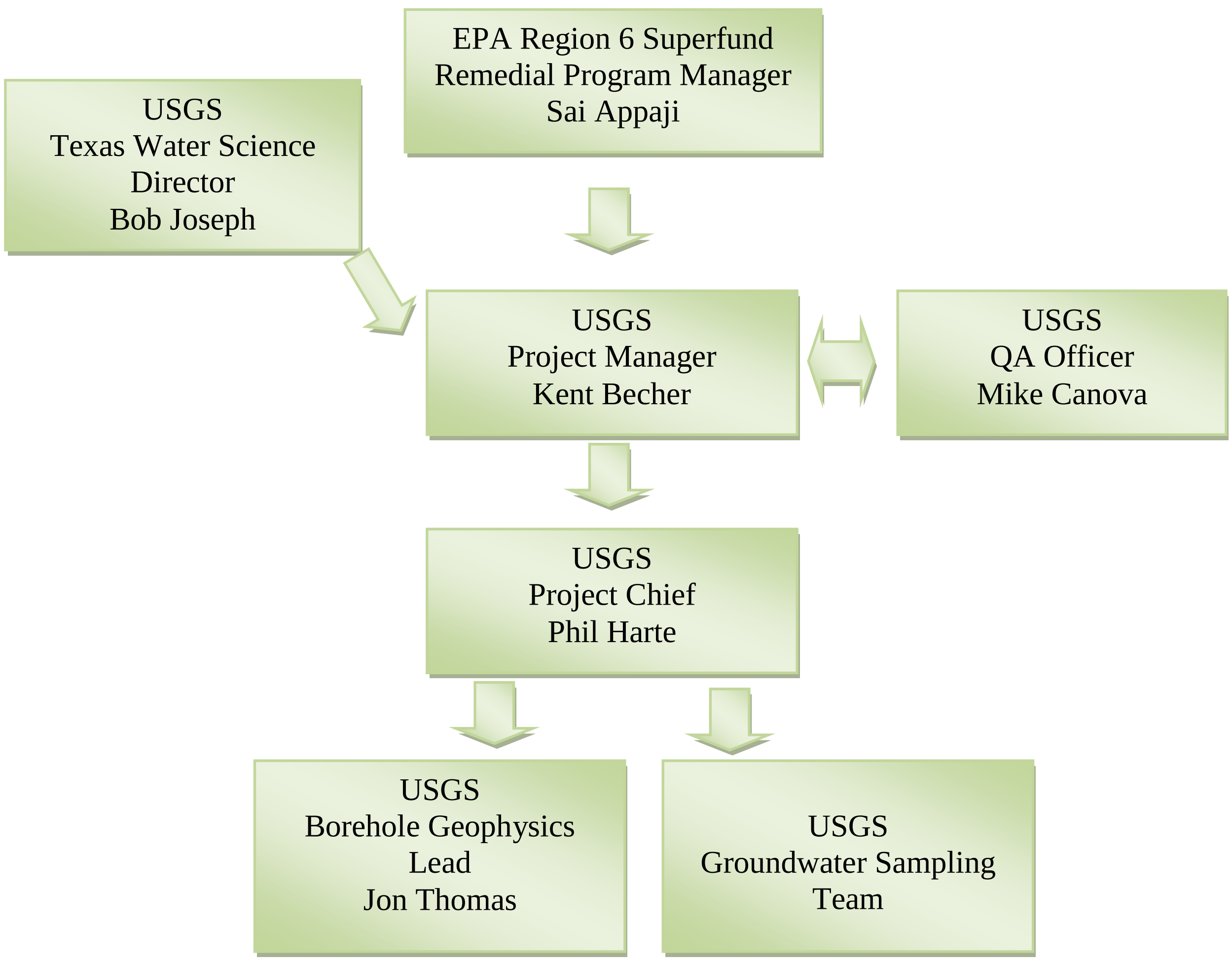
USGS Quality Assurance Officer(QAO) – **Mike Canova** - The QAO is responsible for the following: Serving as the focal point for quality assurance/quality control (QA/QC) oversight of internal reviews, reviewing internal audit reports and providing comments and recommendations, ensuring the QA for this work plan is implemented and followed, objectively evaluating data and performing assessments for selected projects, notifiying internal management of QAPP deficiencies and monitoring, acts as QA liaison to EPA, provides QAPP corrective actions, deals with QAPP non-conformance issues that arise, provides the final review and sign off on all QAPPs, assists in the development of QAPPs, reviews QAPP compliance reports and maintains master QAPP file (QAPPs, deficiency reports, non-conformance reports, etc.).

USGS National Water Quality Laboratory Contracting Officer Coordinator- Gary Cottrell- The contract officer coordinator is responsible for the technical monitoring of the RTI Laboratories. This includes RTI Laboratories performance and data deliveries, and provides liaison and coordination between the USGS project managers using RTI Laboratories.

USGS- Borehole Geophysics lead (BG) - Jon Thomas: The BG will make sure all borehole geophysical equipment is in operational order and oversee the borehole geophysics data collection. The BG will keep the PM/PC informed about the progress of borehole geophysics work. The BG will provide insight to the PM/PC of the borehole log results.

USGS field staff: USGS field staff will follow the direction of the PC. The field staff will have experience in the collection of groundwater samples and will follow USGS documented procedures.

Figure A1**.1- Project organization chart for split sample data collection at Homestake Mining Company, Superfund Site, near Milan, New Mexico.**



A5 Problem Definition/Background

The Homestake Mill Site (Site) is located in Cibola County, just north of the village of Milan and town of Grants, New Mexico. The Site processed raw uranium (U) ore material from external sites starting in 1958; from 1958 to 1990 milling activities continued. A large waste tailing pile (LTP) was constructed starting in the early 1960's. The LTP contained no liner, and processed materials, including waste water as a transporting device, were deposited onto the LTP. Waste water infiltrated into a surficial alluvium aquifer from both the LTP and a small tailings pile (STP) (EPA, 2011). Beginning in 1977 until the present, various levels of remedial activities have been initiated to contain the spread of a U plume emanating from the site and associated with proximal processing activities. These activities included flushing of the tailings from 2000 to 2015. Other contaminants of concern (COCs) include thorium-230, radium-226, radium-228, selenium (Se), molybdenum, sulfate, and total dissolved solids. Private wells in the subdivisions south of the Site have shown elevated levels of COCs. All residences have been hooked up to a safe water source from the Village of Milan.

The Site is underlain by alluvium with a saturated thickness that thins from west (50 feet (ft) to east (20 ft) (Hydro-Engineering, LLC., 2001); the bulk transmissivity of the alluvium also varies from west (10,000 gallons per day per foot (gal/dy/ft)) to east (1,000 gal/dy/ft). Underlying the alluvium are sandstone, limestone, and siltstone that are rock layers of the Chinle and lowermost San Andres Formations. The Chinle Formation comprises three aquifers (upper, middle, and lower) separated by shale. The San Andres Formation is considered one aquifer. Some or all of the four underlying rock aquifers (the three Chinle aquifers in particular) subcrop in various locations in the San Mateo Creek basin. The dip of the Chinle and San Andres aquifers is approximately to the north, which is counter to flow in the alluvium. Groundwater contained in the alluvium recharges the Chinle aquifers at subcrop locations. The rate of recharge from the alluvium to the Chinle is dependent on changes in saturated thickness of the alluvium as waters from up gradient mining legacy locations in the San Mateo basin were transported downgradient. The lower rock aquifers are also intersected by faults that trend northeast-southwest. The East fault bounds the eastern side of the LTP and the west fault bounds the western side of the LTP. The underlying rock aquifers are uplifted to the west of the west fault.

Site background levels for COCs were established for the alluvium and the three separate Chinle aquifers for U, Se, Mo, Cl, NO_3, sulfate, and total dissolved solids (TDS) using site specific data. Cleanup levels for the Site were based on background levels and approved by Nuclear Regulatory Commission (NRC) and concurred by EPA and New Mexico Environment Department (NMED). For the alluvium, cleanup levels are based on concentrations of COCs in the alluvial groundwater interpreted as up gradient of the Site (north of the LTP); specifically from nine wells up gradient (north) of the LTP. Wells further up gradient of the LTP are hypothesized to be affected by regional mining/milling contamination from the upper San Mateo basin as shown by increases in contaminants associated with milling wastes (Homestake Mining Co., 2015). The lower San Mateo basin, in which the Site is located, is situated downgradient (south) from mining and milling activities in the upper San Mateo basin. Closer to the Site, wells located north (generally considered up gradient) of the Site could be affected by local mounding and radial outflow of groundwater affected by tailing wastewater. Several of the proximal wells show a wide range of U concentrations from 0.02 to 0.23 mg/L based on 1995-2004 data as reported in the Homestake Mining Co., (2015) report. Values above 0.1 mg/L (order of magnitude greater) appear to be larger compared to historical data. Historical regional data for the Grants Mineral Belt area show average background concentrations of approximately 0.023 mg/L (Kaufman et al., 1976).

Due to recharge of groundwater from the alluvium to the Chinle aquifers in subcrop areas, a similar standard is being applied to parts of the Chinle aquifers that are deemed as being influenced by alluvium waters. The areas of the Chinle aquifers in which the chemical composition of water has been altered by inflow of alluvium water are called the mixing zone. The Chinle waters are differentiated between mixing and non-mixing based on a calcium concentration of 30 mg/L (> mixing zone).

The site cleanup levels for COC do not meet federal drinking water standards for U (maximum contaminant level (MCL) 0.03 milligrams per liter (mg/L)) partly based on pervasive mining activities in the upper basins and the potential for regional contamination to impact local water quality. The site cleanup level for U is 0.16 mg/L for the alluvial aquifer which is based on concentrations in groundwater located proximal to the Site. Examination of U concentrations north of the LTP from previously published reports on the Site (see Fig. 6.1., Hydro-Engineering LLC, 2001) indicates that low concentrations of U (< 0.16 mg/L) occurred immediately north of the LTP but higher concentrations of U (> 0.16 mg/L) occurred further north.

The analysis of Site historical COC data, which span from 1975 to present, provides one line of evidence on the impact of regional milling activities on water quality. In particular, increases in U and Se concentrations have been measured in far up gradient wells during the monitoring period that can be interpreted as resulting from transport of up gradient, regional waters affected by mines (Homestake Mining Co., 2015). Because transport and arrival of COCs from the LTP could have occurred prior to 1975, it is more difficult to identify local impact from the LTP waste water using this technique because monitoring began 15 to 20 years after operation started at the Site. A number of studies have used chemical fingerprinting as a means to associate chemical signatures in the water with one or more U sources (Basu et al., 2015; Christensen et al., 2004; Zielinski et al., 1997; Yabusaki et al., 2007).Uranium isotopes of U-234 and U-238 have been used to identify anthropogenic effects from milling processes and can be used to differentiate natural and anthropogenic sources of U. Differences in milling processes between regional and local operations can impart differences in the geochemical and isotopic characteristics of water, which can be used to determine if waters are affected by milling wastes. Time of travel constraints from local and distal sources of water and water age can provide additional lines of evidence on whether groundwater has been exposed to milling activities, types of geologic formations, and other hydrogeologic conditions. In summary, incorporation of chemical fingerprinting as a diagnostic tool can aid in the evaluation, along with the arrival times of COC, of exposure avenues of groundwater in the lower San Mateo basin near the Site.

U mobilization is controlled primarily by redox reactions in conjunction with carbonate and calcium concentrations, where the dominant ionic species is typically U^{+6}. Knowledge of these reactions is important when identifying transport pathways of U and assessing the distribution of U as a COC. Milling processes in the basin potentially differ between the Site and mills outside the basin, which may provide other clues into exposure avenues of groundwater.

The EPA and the USGS have a partnership through an interagency agreement. The USGS provides a USGS Technical Liaison (USGS-TL) who is assigned to the Superfund Division of EPA Region 6 in Dallas, Texas. EPA RPMs use the USGS-TL as a resource to help review documents, offer technical advice, attend site specific meetings, and to be a facilitator to find USGS personnel with specialized technical abilities to support EPA's missions. In some cases, an RPM may request the services of the USGS to collect data at a site. The RPM at EPA for Homestake previously has used the USGS personnel in support for reviewing documents, technical advice, and attendance of meetings, thus the USGS personnel are familiar with conditions at Homestake.

During 2015 and 2016, the EPA RPM requested several meetings with the USGS-TL and USGS staff to discuss potential data collection activities to help evaluate background U levels for the Site. The Site is potentially affected by local and regional (basin-wide) tailing operations that can affect U concentrations in groundwater. Further, the site hydrogeology consists of multiple formations with various in situ mineralogy and chemical compositions. A separate work pre-proposal, dated June 2, 2016, was developed by USGS that outlines field collection activities and project objectives. A final full proposal was developed to encompass the entire project after the USGS reviewed the technical content of the scope of the work. In cooperation with the EPA, the USGS will be providing technical support by collecting groundwater samples and borehole geophysical data at the Site. The data collected will be used by the EPA to identify anthropogenic and in situ U concentrations for the alluvial and Chinle formation.

The purpose of this Quality Assurance Project Plan (QAPP) is to clearly describe EPA and USGS QA policy, management structure, and policies that will be used to implement the QA requirements necessary to document the reliability and validity of environmental data. This QAPP will be reviewed by the EPA to ensure that data generated for the purposes described above are scientifically valid and legally defensible.

A6 Project/Task Descriptions and Schedule

Task 1: Quality Assurance Project Plan and Site Health and Safety Plan Preparation: A health and safety plan (HASP) has already been developed for this project and submitted to the EPA. The HASP has been provided as documentation of the requirements for hazardous material work by the Occupational Safety and Health Administration (OSHA). USGS and EPA staff conducted a field reconnaissance in May to determine well locations for data collection, so the HASP was used during the Site visit. The well reconnaissance trip included verifying field locations of wells using a handheld global positioning system (GPS) unit and inspecting the wells for field sampling suitability. Table 1 lists the wells that were identified and are anticipated for use in this study. A USGS station identification will be established from the GPS coordinates so that data collected can be entered into the USGS National Water Information System (NWIS). This project QAPP is being developed to provide detailed steps in data collection, analysis and to quality control and assurance.

Table 1: Well name, depth, aquifer, casing, screen, and planned sampling for wells located at or near Homestake Mill Site, Milan, NM

[bls, depth in feet below land surface; A, alluvium,; LC, lower Chinle; MC , middle Chinle, UC, upper Chinle, ft, feet; **Bold** well name, optional well for sampling, Y; yes, N; No]

Name	Depth (bls)	Aquifer	Casing diameter-inches	Screen (bls)	Length of screen (ft)	Sample	Geophysical logging	Flowmeter logging	Passive sampling
MV	105	A	4.5	75-105	30	**Y**	**Y**	**N**	**Y**
DD	78.5	A	4	40-80	40	**Y**	**Y**	**Y**	**Y**
DD2	94.3	A	5	50-90	40	**Y**	**Y**	**Y**	**Y**
ND	70	A	4	50-70	20	**Y**	**Y**	**Y**	**Y**
P3	95	A	5	55-95	40	**Y**	N	N	N
T11	193	A	5	113-193	80	**Y**	**Y**	**Y**	**Y**
CW50	170	UC	5	130-170	40	**Y**	N	N	N
CW2	355	MC	5	306-353	47	**Y**	N	N	N
CW15	134.6	MC	5	73-133	60	**Y**	N	N	N
820	230	MC	0	125-230	105	**Y**	N	N	N
CW28	370	MC	5	280-360	80	**Y**	N	N	N
CW1	325	MC	5	212-323	111	**Y**	N	N	N
CW18	230.7	UC	5	177-232	55	**Y**	N	N	N
n-17	70	A	2	60-70	10	**Y**	Y	N	N
Q	98.3	A	4	72-102	30	**Y**	**Y**	**Y**	**Y**
484	320	MC	5	220-300	80	**Y**	N	N	N
ACW	325	MC	6	265-325	60	**Y**	N	N	N
CW45	193	MC	5	163-193	30	**Y**	N	N	N
CE7	120	UC	6	100-140	40	**Y**	N	N	N
CW26	300	LC	5	245-285	40	**Y**	N	N	N
CW37	150.1	LC	5	100-150	50	**Y**	N	N	N
ST	97	A	5	55-97	22	**Y**	N	N	N
920	--	A	7	--	--	**Y**	N	N	N
INJECTATE	--	--	--	--	--	**Y**	N	N	N
AW	156	UC	6	66-155	89	Y	N	N	N
922	--	--	--	--	--	Y	N	N	N
MO	88	A	4.5	45-85	40	**Y**	N	N	N
916	160	A	4	45-70	25	N	N	N	N

Task 2: Borehole geophysics: The USGS will collect borehole geophysical data from seven pre-selected wells (table 1). Depending on well construction, the borehole tools to be used on these wells will include induction, fluid resistivity, natural gamma, spectral gamma, fluid

temperature, caliper, casing collar locator, and optical tele-viewer. In addition to this suite of logs, electromagnetic flowmeter logging will be done in up to five boreholes (table 1) under ambient and stressed (pumped) conditions. Where possible, pump rates will be set at rates typically done for purging and sampling at the Site. Geophysical data collected from these wells will be used to evaluate well construction, stratigraphy, distributions of potassium, uranium, and thorium, and inflow and outflow intervals of a well under ambient and pumped conditions. Flowmeter data collected under ambient and pumped conditions will be used to improve the understanding of well hydraulics and to assist task 3 and task 4 interpretations. Table 2 lists the geophysics logs planned for the project.

Table 2: Geophysical techniques to be used at the Homestake Mill Site, Milan, NM

Tool Name	Model	Manufacturer	Parameters	Site Use
Caliper	7074	Century	3-Arm Caliper	Standard Operating Procedure to run first; Confirm casing and screen are in acceptable condition
			Casing Collar Locator	Indicate metallic objects in well such as metal collars or centralizers
Multi-Parameter E-Log	8144	Century	Natural Gamma	Bed boundary analysis; General lithology; Assessment of coarsening/fining; Depth Matching
			Spontaneous Potential	Not applicable in PVC wells
			64" Long Normal Resistivity	Not applicable in PVC wells
			16" Short Normal Resistivity	Not applicable in PVC wells
			Lateral Resistivity	Not applicable in PVC wells
			Single Point Resistance	Qualitatively indicate PVC screen
			Temperature	Identification of vertical and horizontal flow zones; Assessment of wellbore properties
			Fluid Resistivity	Assessment of vertical and horizontal flow zones; Wellbore fluid assessment
Slim Hole Induction	9512	Century	Natural Gamma	Bed boundary analysis; General lithology; Assessment of coarsening/fining; Depth Matching
			Induction	Bed boundary analysis; General lithology; Assessment of coarsening/fining; General formation fluid assessment
EM Flowmeter	9722	Century	EM Flowmeter	Assessment of ambient and stressed vertical flow; Assessment of screened producing zone properties; Assessment of water quality sample sources;
			Fluid Resistivity	Assessment of fluid property changes between ambient and stressed conditions
			Temperature	Assessment of fluid property changes between ambient and stressed conditions
Optical Televiewer	OBI-40	Mount Sopris	Optical Image	Confirm completion properties; Assessment of screen type and condition
			Deviation	Assessment of well construction
Spectral Gamma	2LSA-1000	Mount Sopris	Spectral Gamma	Identify facies changes and depositional environment; Identify and classify lithology types

Task 3: Passive sampler deployment: The passive samplers (nylon-screen passive samplers (NSPS)); Vroblesky and others, 2002, 2003) will be deployed downhole in 6 wells (table 1) in vertical strings to map vertical variation in U and selenium (Se). A maximum of 11 NSPS per well will be deployed; depths of samplers are coincident with open intervals of wells and formation contacts as determined by borehole geophysical logging and reported drill logs. The samplers consist of 250 ml bottle, covered with a 125 micron mesh screen, held in place with the collar of a standard cap (hole drilled out of top of cap). The samplers consist of deionized (DI) water of known U and Se concentration. Samplers are held in place inside a vexar sock mesh and suspended with a ¼ inch diameter nylon line and stainless steel weight. The samplers are deployed with the mesh facing downward. Inverting the samplers in this way prevents the introduction of borehole water from above the sampler to be pushed into the sampler during retrieval.

The NSPS will be tested against a known standard value of U and Se to assess the ability of the NSPS to collect representative U and Se concentrations in a well. Prior to deployment, the samplers will be tested against known standards of U and Se by immersing the samplers for two weeks inside a standard (U and Se) bath (one bath each for U and Se). The bath will be exposed to a low level of periodic (minimum of 2 times) circulation to ensure mixing by inducing convective circulation within the bath. Convective circulation will be generated by temporality covering the bath with clear plastic and an ice pack for 30 minutes. After several weeks, at the end of the bath experiment, the bath water and the water from inside the sampler will be sent in for analysis of U and Se by EPA method 6020 (table 3). The DI water from the sampler will be tested for U and Se from an equipment blank that is not exposed to the baths but exposed to atmospheric conditions inside the lab where the testing is taking place.

For passive samplers, an equipment blank sample is collected and submitted for analysis after deployment of all samplers downhole (pre-monitoring). The equipment blank serves multiple purposes, as a blank of the DI and to ensure no contamination occurred pre-deployment of samplers. Sample duplicates are collected at each well by doubling up on samplers at fixed locations downhole. Sample duplicates are collected from separate bottles but similar depths.

Task 4: Passive Sampler Recovery/Groundwater sampling: The NSPS will be left downhole in place for two weeks to one month. The USGS will recover the passive samplers, replace the nylon screen mesh that covers the open mouth of the bottle, and cover opening with a regular cap. No filtering is required. The samples will be analyzed for U and Se by EPA method 6020 (table 3). The condition of the samplers will be noted to ensure mesh is in place and whether iron-staining is evident or leakage occurred from the sampler. Iron staining denotes redox reaction from mixing of different waters-potentially oxygenated water from the sampler with reduced water from the well borehole. Upon retrieval, samplers will be preserved, capped, and shipped to the laboratory. A trip blank is included with the samples. After retrieval, a micropurged sample will be collected at the position of the lowest sampler by dropping a low flow rate pump to a coincident depth. The micropurge sample will use a low flow pump and evacuate the equivalent of two tube and pump volumes of water prior to sampling for U and Se. New, ¼ inch diameter polyethylene tubing will be used per well. An unfiltered (total) and 0.45 micron filtered sample will be collected. The 0.45 micron filter sample will be collected after the unfiltered sample and after allowing for flushing of the filter cartridge (1 minute or 300 ml).

Field parameters dissolved oxygen (DO), temperature, conductivity, turbidity and pH) will be collected after the sample so as to minimize evacuation of relatively large volumes of water, which would induce an equivalent increase in capture zone during micropurge sampling. The micropurge sample will allow for a comparison of the filtered and unfiltered concentrations for U and Se and for a comparison to the passive samplers that represent a quasi-filtered state.

The USGS will collect groundwater samples from up to 24 wells (tables 1 and 3). The groundwater samples will be collected one set per well after purging 3 borehole volumes. Purge rate will duplicate historical purge rates from the wells, which is typically 10-30 gal/min. Purge waste water will be discarded according to site protocol.

During purging, water levels, and common field parameters will be tracked using a calibrated water level meter, and continuous YSI sonde DO, temperature, pH, turbidity, and water conductivity (appendix A). Daily calibration field sheets will be kept for the YSI sonde. Post sampling checks will be done on the YSI to identify daily drift at end of day. Purge rates will be measured by a flow meter. The samples will be collected using the same criteria (following previously purged volume amounts). An inline flowmeter will be used to track purge volume and allow better tracking of response of field parameters to purging. A portable YSI will be calibrated to known standards. New ABS, 1-inch diameter sampling tubes will be used at each well in order to avoid a risk of cross-contamination between wells. In addition, downhole submersible pumps will be decontaminated after each well. Prior to sampling, one measurement of DO and ferrous iron will be measured using field kits (USGS, 2016).

Sampling will be done from a valve and “T” set up. The flow rate off the “T” will be approximately 300 ml/min to minimize turbulence and the other water will be discharged to waste. At each well, samples will be collected in a prescribed sequence to maximize consistency.

Table 3: Constituents, method, containers, preservatives, and holding times for analytical methods

[ml, milliliter; oz, ounce; C, Celsius; CFC, chlorofluorocarbon]

Description	Method	Container	Preservation	Holding Time
Metals	6020	250 mL plastic	HNO_3 , 4° C	180 days
Alkalinity	SM2320B	250 mL plastic	4° C	14 days
Ammonia	SM4500	250 mL plastic	H_2SO_4 , 4° C	28 days
Br, CL, F, SO_4	300	120 ml plastic	4° C	28 days
Nitrogen	SM4500	250 ml plastic	H_2SO_4 , 4° C	28 days
Gross alpha/beta	900	250 ml plastic	pH<2 HNO_3	180 days
Radium isotopes	903.1/904	250 ml plastic	pH<2 HNO_3	180 days
Uranium isotopes	HASL 300	250 ml plastic	pH<2 HNO_3	180 days
Carbon 14	Liquid scintillation	500 ml polyethylene bottle	none	180 days
Stable isotopes of deuterium (δD) and oxygen-18 (δ18O)	Revesz and Coplen 2000a and b	2 oz (60 ml) glass with polyseal cap	Store at ambient temperature	Months
Sulfur isotopes	Revesz and Coplen 2000a and b	1 Liter polyethylene bottle	Filtered with .4 µm polycarbonate membrane filter	Months

Description	Method	Container	Preservation	Holding Time
Nitrogen isotopes	Revesz and Coplen 2000a and b	4 oz (125 ml) amber polyethylene bottle	Filtered with .4 µm polycarbonate membrane filter followed by a 0.2 µm syringe filter, freeze sample	Months
He-4	Revesz and Coplen 2000a and b	3 septum glass bottles (150) ml)	4° C	3 years
Dissolved gases	See attachment 3	copper tubing, properly sealed	none	years
Tritium/He-3	See attachment 3	2 500cc (16 oz) Nalgene plastic bottle)	none	years
CFCs	See attachment 3	5 125 ml Boston round clear glass bottles with cap with an aluminum foil linear	none	30 days

The samples will be analyzed for a complete suite of geochemical, isotopic, and age dating constituents (USGS, 2016). Appendix A includes procedures for the multiple different types of samples being collected for this study.

Task 5: Reporting: A USGS data release is anticipated to facilitate the distribution of information from this project. This will allow for the quickest delivery of high quality information from this effort. The data release is non-interpretive, so follow-up, and interpretive, deliverables are scheduled. The data will be available through ScienceBase. ScienceBase is a web clearing house for scientific information.

Task 6: Data analysis and presentation:
Interpretation of chemical results is needed to address project objectives. A presentation is planned to highlight important findings and to allow for collaborative discussions with stakeholders.

Geochemical trilinear diagrams will be generated and samples coded to help identify differences in water type and potential geochemical reactions transforming the groundwater chemistry. Stable isotopes will be plotted against each other to identify deviations from the standard conditions. Ratios of U and Th concentrations will be computed to identify anthropogenic sources of U from enrichment processes. Age dating of groundwater samples will be collected, computed, and analyzed. The software program TracerLPM (Jurgens, and others, 2012) will assist in analysis.

Task 7: Interpretive reporting:
A peer-reviewed short journal paper is planned to provide final interpretive findings. The paper will focus on identifying chemical signatures that helped differentiate processes, water types, and sources of water to the groundwater of the study area. A companion factsheet will be produced to summarize important findings from the technical paper. The factsheet target audience is non-

technical so as to convey and explain conclusions from the study to stakeholders. The USGS will make all chemical quality data accessible through ScienceBase.

QAPP Amendments

Amendments to the QAPP may be necessary to reflect changes in project organization, tasks, schedules, objectives and methods; address deficiencies and non-conformances; improve operational efficiency; and/or accommodate unique or unanticipated circumstances. Requests for amendments are directed from the USGS PM to the EPA RPM. The changes are effective immediately upon approval by the EPA RPM or his or her designees. Amendments to the QAPP and the reasons for the changes will be documented, and revised pages will be forwarded to all persons on the QAPP distribution list by the USGS QC/QAO.

Table A6.1 Homestake Timeline

Task	May	June	July	Aug	Sept	Q1-FY17	Q2-FY17	Q3-FY17	Q4-FY17
Task 1: Development of proposal, QAPP and health and safety plan									
Task 2: Borehole geophysical logging									
Task 3: Installation of passive samplers									
Task 4: Water-quality sampling									
Task 5 Data compilation and reporting									
Table 6: Data analysis and presentation									
Task 7: Interpretive reporting									

A7 Quality Objectives and Criteria for Measurement Data

The primary objective of this project is to distinguish between anthropogenic and background contributions of U concentrations at selected well locations in the vicinity of the Site in the alluvium and Chinle aquifers. The secondary objective of this project is to differentiate water type between the three main sources of water in the alluvium and Chinle aquifers near the Site. The three main water sources include: (1) waters unaffected by local or regional tailing operations, (2) waters affected by local tailing operations, and (3) waters affected by regional, up gradient tailing operations in the basin. Lastly, Chinle aquifer waters have been grouped at the Site into two main water types-mixing and non-mixing waters based on a calcium concentration of 30 mg/L (< non-mixing) (Hydro-Engineering, LLC., 2001). Chemical differences in water type between the two mixing groupings will be determined including differences in age of waters.

DQO’s are qualitative and quantitative criteria for clarifying project objectives, defining the appropriate types of data needed, and defining the tolerable levels of potential decision errors for the project. It is a systematic planning process to generate environmental data appropriate and sufficient for its intended use. The process is designed to answer four basic questions:

1). What data is needed?
2). Why is it needed?
3). How will the data be used?
4). What tolerance does the user have for decision errors?

The DQO process is a method to ensure that the collection and analysis of data for a project meets the requirements for the specific project goal and that the environmental data generated will be sufficient for their intended use.

The data-quality objectives for this project are as follows:

- Determine the borehole geophysics physical properties within selected groundwater wells including well construction, stratigraphy, borehole inflow and outflow under ambient and pumped conditions.
- Determine the presence of U and Thorium (Th) in formations with natural gamma and spectral gamma logs.
- Determine the vertical variability of concentrations of U and Se at selected groundwater wells and if high U and Se are associated with high natural gamma and spectral gamma signals.
- Determine the likely source of water (formation type) during standard purging procedures of selected wells.
- Determine chemical signatures (locally impacted, regionally impacted, and background) of groundwater as it relates to selected wells.
- Determine U and Se concentrations in wells with different chemical signatures that are associated with locally impacted, regionally impacted, and background waters.

The purpose of this project is to help identify local (nearby Site) and regional (basin wide) chemical signatures from mining/tailing operations. Specifically, an important objective is to identify anthropogenic and background water concentrations of U at selected specific well locations in the vicinity of the Site for the alluvium and Chinle aquifers. Chemical signatures will be related to the concentration of U in groundwater. Wells selected for study (borehole geophysical logging, and passive and purged sampling) reflect wells previously identified as representative of the three main types of groundwater: 1) background, 2) regionally impacted, and 3) locally impacted. By comparing chemical signatures from these wells, an assessment of the impact of local and regional contamination on presumed background waters may be obtained. Analytical data will comply with established requirements for quality assured data.

The measurement performance specifications to support the project objective are specified in Table A7.1.

Table A7.1: Data-Quality Objectives

[LOD, limit of detection; MDL, method detection limit; LOQ, limit of quantification,; PQL, practical quantification level: mg/L, milligrams per liter; µg/L, micrograms per liter, pCi/L, picocuries per liter; nmol/kg; nanomole per kilogram, CFCs; chlorofluorocarbons]

RTI Laboratory Method 2320B

Analyte	Units	Synonym	MDL	LOD	LOQ	PQL
Alkalinity, Total (As CaCO3)	mg/L CaCO3	Alkalinity, Total	4.53	10	NA	20

RTI Laboratory Method 2540C

Analyte	Units	Synonym	MDL	LOD	LOQ	PQL
Residue, dissolved	mg/L	TDS	5	5	5	5

RTI Laboratory Method 300

Analyte	Units	Synonym	MDL	LOD	LOQ	PQL
Bromide	mg/L	Br	0.01	0.03	0.05	0.1
Chloride	mg/L	Cl	0.04	0.05	0.1	0.1
Fluoride	mg/L	F	0.04	0.05	0.1	0.1
Sulfate	mg/L	SO_4	0.04	0.05	0.1	0.1

RTI Laboratory SM4500

Analyte	Units	Synonym	MDL	LOD	LOQ	PQL
Nitrogen, Nitrate-Nitrite	mg/L	NO_3	0.007	0.025	NA	0.05
Ammonia Nitrogen	mg/L	NH_3	0.012	0.024	NA	0.1

RTI Laboratory Method 6020

Analyte	Units	Synonym	MDL	LOD	PQL
Antimony	µg/L	Sb	0.038	0.15	0.5
Arsenic	µg/L	As	0.122	0.2	0.3
Barium	µg/L	Ba	0.037	0.1	5
Cadmium	µg/L	Cd	0.054	0.1	0.2
Calcium	µg/L	Ca	18.06	25	200
Chromium	µg/L	Cr	0.061	0.1	2
Cobalt	µg/L	Co	0.024	0.1	1
Copper	µg/L	Cu	0.049	0.1	1
Iron	µg/L	Fe	9.541	25	40
Lead	µg/L	Pb	0.048	0.1	0.2
Magnesium	µg/L	Mg	8.126	25	100
Manganese	µg/L	Mn	0.053	0.1	1
Molybdenum	µg/L	Mo	0.143	0.2	1
Nickel	µg/L	Ni	0.041	0.1	2
Potassium	µg/L	K	21.14	25	100
Selenium	µg/L	Se	0.291	0.5	1
Sodium	µg/L	Na	11.51	25	100
Tin	µg/L	Sn	0.071	0.5	5
Titanium	µg/L	Ti	0.344	0.5	10
Uranium	µg/L	U	1.347	2	5
Vanadium	µg/L	V	0.098	0.1	0.8
Zinc	µg/L	Zn	0.351	0.5	10

PACE Laboratories Method 900

Constituents	Reporting level
Gross alpha/beta	3 pCi/L

PACE Laboratories SM7500/RN/CIN5013

Constituents	Reporting level
Radon-222	100 pCi/L

PACE Laboratories 903.1/904

Constituents	Laboratory
Radium isotopes (226Ra/228Ra)	PACE

PACE Laboratories HASL 300

Constituents	Reporting level
Uranium isotopes (U-234, U-235, U-238)	1 pCi/L

PACE Laboratories Liquid Scintillation

Constituents	Reporting level
Carbon 14	10 pCi/L

USGS Reston Stable Isotope Laboratory Methods Revesz and Coplen 2000a and b, LC 1142

Constituents	Reporting level
Stable isotopes	2-sigma uncertainty of isotopes per 1.0 millimeters

USGS Reston Stable Isotope Laboratory Method Revesz and Coplen 2000a and b LC1951

Constituents	Reporting level
Sulfur isotopes (s32,s34,O18,O16)	2-sigma uncertainty of isotopes per 0.4 millimeters

USGS Reston Stable Isotope Laboratory Method Coplen and others, 2012

Constituents	Method	Reporting level	Laboratory
Nitrogen isotopes	LC 2900	2-sigma uncertainty of isotopes per 0.5 millimeters	Reston Stable Isotope

USGS Reston Stable Isotope Laboratory Method Revesz and Coplen 2000a and b

Constituents	Reporting level
He-4	1 nmol/kg

University of Utah Dissolved and Noble Gas Laboratory Methods (see attachment 3)

Constituents	Reporting level
Dissolved gases	± 1% to 5% of value
Tritium/He-3	0.05 TU
CFCs	± 5% of value

A7.1 Precision

See RTI Laboratory, PACE Laboratory, and University of Utah, quality assurance plans [attachments 1, 2, and 3]

A7.2 Accuracy

See RTI Laboratory, PACE Laboratory, and University of Utah, quality assurance plans [attachments 1, 2, and 3]

A7.3 Representativeness

See RTI Laboratory, PACE Laboratory, and University of Utah, quality assurance plans [attachments 1, 2, and 3]

A7.4 Comparability

See RTI Laboratory, PACE Laboratory, and University of Utah, quality assurance plans [attachments 1, 2, and 3]

A.7.5 Completeness

See RTI Laboratory, PACE Laboratory, University of Utah, and USGS Reston lab quality assurance plans [attachments 1, 2, and 3]

A8 Training Requirements/Certifications

The USGS field personnel all have previous experience with monitoring well sampling and conducting field analyses and monitoring well water-level measurements. The geophysics crew is highly experienced and collects borehole and geophysics data on regular basis. In addition, since this is a Superfund site all USGS staff members will be current with their 8-hour refresher hazardous waste training.

A9 Documentation and Records

The documents that describe, specify, report, or certify activities, requirements, procedures, or results for this project, and the items and materials that furnish objective evidence of the quality of items or activities are listed in the sections below. RTI Laboratories, PACE Laboratories, and University of Utah Laboratories describes their document control procedures in their individual QAPs (attachments 1, 2, and 3).

A9.1 Data

The data collected from this study will be provided to EPA in paper copy and electronic form through the use of ScienceBase.

A9.2 Field Documentation

The field team is responsible for the collection, documentation, and custody of the ground water samples collected. Proper documentation of the sampling is essential to the data collection effort. Field logbooks will be used for documentation at each well sampling site. The logbooks will have page numbers and any entry into the logbook must be done in pen. For the purposes of this section and subsequent sections, all field and laboratory personnel must follow the basic rules for recording information as documented below:

1. Legible writing in indelible ink with no modifications, write-overs or cross-outs;
2. Correction of errors with a single line followed by an initial and date;
3. Close-out on incomplete pages with an initialed and dated diagonal line.

The logbook will include the following information during sampler installation and retrieval:

- Monitor well ID number
- Date
- Field crew names
- Well integrity notes, general notes on well location
- Measuring point used
- Initial water level (taken twice and must be within 0.02 feet of each other, if not repeat) prior to sampling
- Signature of recorder and date, don't leave extra space on bottom of page, strike out and initial and date

All other well sampling information will be recorded on the Ground-Water Field Data Work Sheets (appendix B). Borehole geophysics notes and information in the field will be recorded on Geophysical Logs Field Data Work Sheets (appendix C). Passive sampler notes and information will be recorded on Passive Sampler Work Sheets (appendix D).

Proper sample handling and custody procedures ensure the custody and integrity of samples beginning at the time of sampling and continuing through transport, sample receipt, preparation, and analysis.

A sample is in custody if it is in actual physical possession or locked in a vehicle under the control of USGS authorized field personnel. The chain of custody (COCs) forms is used to document sample handling during transfer from the field to the contract laboratory. A completed COC will be placed into a waterproof Ziplock® plastic bag inside the respective cooler which will be sealed with clear packing tape. Two custody seals will be placed on the cooler, and the cooler will then be Federal Expressed overnight to the selected contract laboratory. When transferring samples, the individuals relinquishing and receiving the coolers containing samples will sign, date, and note the time on the chain-of-custody record.

Once samples are received at the RTI Laboratories, PACE Laboratories, University of Utah Laboratories, and the USGS Reston Laboratory the sample custodian receives the samples and logs the samples into the laboratory, the COC is then scanned and a copy of it and a notification letter will be emailed to the PM. RTI Laboratories, PACE Laboratories, University of Utah Laboratories, and the USGS Reston Laboratory COC are maintained in a safe and secure manner at all times.

The documents and records that describe, specify, report, or certify activities are listed in Table A9.

Table A-9: Project Documents and Records

Document/Record	Location	Retention (yrs)	Format
QAPP, amendments, and appendices	USGS/EPA	5 years	Paper/Electronic
QAPP distribution documentation	USGS	5 years	Paper/Electronic
Field notebooks	USGS	5 years	Paper
Groundwater field sheets	USGS	5 years	Paper
Borehole geophysics field sheets	USGS	5 years	Paper/Electronic
Electronic data collected geophysics	USGS	5 years	Paper
Chain of custody records	USGS	5 years	Paper/Electronic
Laboratory sample reception logs	USGS	5 years	Paper
Laboratory calibration records	USGS	5 years	Electronic
Laboratory data verification for integrity, precision, accuracy and validation	USGS	5 years	Paper
Laboratory equipment maintenance logs	USGS	5 years	Paper
Laboratory QAPP	USGS	5 years	Paper
Quality control	USGS	5 years	Paper
Final report / data	USGS/EPA	3 years	Paper/Electronic

The EPA will receive all the information listed in Table A.9 for data archival.

The estimated data reporting turnaround time for the constituents to be analyzed is approximately 30 days (analyses data report) after the samples are delivered to the selected laboratory.

Difficulties or unusual events during sampling or analyses will be noted and reported to the EPA RPM by the USGS PM.

B1 Sampling Process Design

See section A6 of this QAPP for sampling process design information associated with data collected for this project.

B2 Sampling Methods

B2.1 Field Sampling Procedures

Please see section A6 and Appendix A

B2.2 Processes to Prevent Cross Contamination

Please see section A6 and Appendix A

B2.3 Documentation of Field Sampling Activities

Please see section A9 in this QAPP.

B2.4 Deviations from Sampling Method Requirements or Sample Design and Corrective Action

Deficiencies are defined as unauthorized deviations from procedures documented in the QAPP or other applicable documents. Non-conformances are deficiencies which affect data quantity and/or quality and render the data unacceptable or indeterminate. Deficiencies related to field sampling methods requirements include, but are not limited to, such things as neglecting to follow proper procedures as outlined in the Work.

Deficiencies are documented in logbooks by USGS field personnel who will notify the USGS PC and the USGS PM. The PC/PM will determine whether it is necessary to initiate a Nonconformance Report (NCR) to document the deficiency.

The USGS PC/PM in consultation with the USGS PC/PM/QAO will determine if the deficiency constitutes a nonconformance. If it is determined the activity or item in question does not affect data quality and therefore, is not a valid nonconformance, the NCR will be completed accordingly and the NCR closed. If it is determined a nonconformance does exist, the USGS PC/PM/QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented in USGS Corrective Action Report.

Corrective Action Reports (CARs) document: root cause(s); impact(s); specific corrective action(s) to address the deficiency; action(s) to prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and the means by which completion of each corrective action will be documented. In addition, significant conditions (i.e., situations which, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to the EPA RPM immediately both verbally and in writing.

B3 Sampling Handling and Custody

B3.1 Chain-of-Custody

Proper sample handling and custody procedures ensure the custody and integrity of samples beginning at the time of sampling and continuing through transport, sample receipt, preparation, and analysis.

A sample is in custody if it is in actual physical possession or locked in a vehicle under the control of USGS authorized field personnel. Selected laboratory COC forms will be used to document sample handling during transfer from the field to the selected laboratory.

1) Field Sample ID
2) Date and time of collection
3) Cost code for the laboratory
4) Name of staff member(s) who collected the samples
5) Name of staff member who submitted the samples
6) Sample submitter's contact information
7) Type of sample(s)
8) Project name and location
9) Relinquished signature, date, and time
10) Laboratory staff received signature, date, and time

B3.2 Sample Labeling

The samplers will be labeled with the monitoring well ID number already established for the wells at the Site. The date and time of collection will also be written on the sample labels.

B3.3 Sample Handling and Shipment

Sample handling and shipment procedures are located in section A6 and Appendix A.

B3.4 Deficiencies, Non-conformances and Corrective Action Related to Chain-of-Custody

Deficiencies are defined as unauthorized deviations from procedures documented in the QAPP or other applicable documents. Non-conformances are deficiencies which affect data quantity and/or quality and render the data unacceptable or indeterminate. Deficiencies related to COC include but are not limited to delays in transfer, incomplete documentation, including signatures; possible tampering of samples; broken or spilled samples, etc.

Deficiencies are documented in logbooks by USGS field personnel and reported to the USGS PC. The PC/PM/QAO will initiate a NCR to document the deficiency.

The USGS PC will determine if the deficiency constitutes a nonconformance. If it is determined the activity or item in question does not affect data quality and therefore, is not a valid nonconformance, the NCR will be completed accordingly and the NCR closed. If it is determined a nonconformance does exist, the USGS PC/QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by the USGS PC/PM/QAO by completion of a CAR.

CARs document: root cause(s); impact(s); specific corrective action(s) to address the deficiency; action(s) to prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and the means by which completion of each corrective action will be documented. CARs will be included with monthly progress reports. In addition, significant conditions (i.e., situations which, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to the immediately EPA RPM both verbally and in writing.

B4 Analytical Methods

See section A7 of this QAPP.

B5 Quality Control

B5.1 Sampling Quality Control and Acceptability Criteria

All environmental projects require a comprehensive and multifaceted approach to QA/QC in order to achieve and document attainment of appropriate quality for the intended data usage. The project manager is the focal point to ensure that chemical DQOs are established for his or her project. The PC can use several techniques to monitor and ensure the quality of chemical data. These include:

- Appropriate sampling protocols.
- Field blanks, ambient blanks, and replicates.
- Sample handling QA.
- QA sample collection and field analyses.
- Field data review.
- Laboratory QA and QC.
- Review of primary laboratory data.
- Validation of data.
- Technical review of written products

For this ground water sampling effort, QA/QC samples will include at least one field equipment blank per sampling team (3 teams), at least three duplicate samples, and a source blank (passive samplers). The water-quality meters will be calibrated twice daily, both prior to and after daily ground water sample collection.

Quality sample design is an important component of quality assurance. For this project only one set of samples will be collected from each of the selected wells, so understanding the data from a single sampling event is somewhat challenging. The intent of this study is not to determine background concentrations, but to evaluate whether certain wells are indicative of ambient groundwater. In order to complete that objective, the quality assurance data collected will be used in conjunction with other laboratory data to determine if there is any sampling bias, matrix interference, or laboratory bias. Laboratories chosen for use in this project indicate their analytical methods meet the data quality objectives of this study and that additional QA/QC data is available for analysis (lab duplicates, blind samples, and etc).

Quality control procedures differ based on sampling method-either passive or active (called purge sampling). During passive sampling a NSPS with a 125 micron mesh is used. To ensure passive sample devices can come to an equilibrium with U and Se, the NSPS will be tested by deploying the NSPS in a known concentration bath for a minimum of 2 weeks. The NSPS are filled with DI water with known U and Se concentration prior to deployment. After deployment in the bath, the water from the NSPS and the bath water are submitted to the laboratory for analyses. Differences are noted. A comparable comparison study was done by Columbia laboratories and results reproduced below.

	14-Day Deployment			21-Day Deployment		
Metals	Jar (mg/L)*	RPPS (mg/L)	Migration (%)**	Jar (mg/L)*	RPPS (mg/L)	Migration (%)**
Antimony	0.0878	0.0810	92%	0.0847	0.0799	94%
Arsenic	0.0840	0.0768	91%	0.0853	0.0830	97%
Barium	0.0900	0.0845	94%	0.0884	0.0840	95%
Beryllium	0.0855	0.0749	88%	0.0867	0.0797	91%
Cadmium	0.0885	0.0782	88%	0.0900	0.0829	92%
Chromium	0.169	0.152	90%	0.177	0.160	90%
Cobalt	0.0892	0.0797	89%	0.0918	0.8510	93%
Copper	0.148	0.0927	63%	0.546	0.276	51%
Nickel	0.871	0.628	72%	0.972	0.819	84%
Selenium	0.0715	0.0687	96%	0.0746	0.0744	100%
Silver	0.0466	0.0141	30%	0.0391	0.0147	38%
Thallium	0.0805	0.0858	107%	0.0890	0.0852	96%
Vanadium	0.0852	0.0762	89%	0.0872	0.0809	93%
Zinc	0.0968	0.1040	107%	0.0980	0.0972	99%

* 20 L Glass carboy

** Sampler concentration/Jar concentration X100

Duplicate samples – Duplicate ground water samples will be collected at least on a daily basis, approximately one duplicate for every ten monitoring wells that are sampled. The precision of duplicate results are calculated by relative percent difference (RPD) using the following equation:

$$RPD = (X1-X2)/ ((X1+X2)/2))$$

Equipment Blanks- For passive sampling, a combined field/equipment blank is used. The combined blank is a constructed NSPS with DI water. For purge sampling, at least one equipment blank will be collected daily during ground water sampling activities. The equipment blanks will be collected at the well sites, using de-ionized water, which will be pumped through a decontaminated pump and tubing into an entire set of sample containers. The samples will then be capped, labeled, and logged onto the COC and sent in for analyses with the rest of the samples, on a daily basis.

B5.2 Laboratory Measurement Quality Control and Acceptability Criteria

See attachments 1, 2, and 3.

B5.3 Deficiencies, Non-conformances and Corrective Action Related to Analytical Methods Failures in Quality Control and Corrective Action

The USGS PC is to inform the USGS PM of any deficiencies in regards to analytical methods and laboratory QC. In this case, the USGS PC/PM and the selected laboratory representative will work together on the results of the environmental and QC samples to evaluate the reliability of the analytical results from the sampling excursions. The arbitrary rejection of results based on predetermined limits is not practical because differences in field duplicate sample results are used to assess the entire sampling process, including environmental variability. Therefore, the professional judgment of the USGS PC/PM and the selected laboratory representative will be relied upon in evaluating results. Rejecting sample results based on wide variability is a possibility.

CARs document: root cause(s); impact(s); specific corrective action(s) to address the deficiency; action(s) to prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and, the means by which completion of each corrective action will be documented. In addition, significant conditions (i.e., situations which, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to the EPA RPM immediately both verbally and in writing.

B5.4 Borehole Geophysics

All logs collected for this study will be collected according to the American Society of Testing and Materials (ASTM) borehole geophysical standard procedures: (1) ASTM Standard Guide for Planning and Conducting Borehole Geophysical Logging - D5753-05 (American Society of Testing and Materials, 2010), (2) ASTM Standard Guide for Conducting Borehole Geophysical Logging Mechanical Caliper - D6167 – 97 (American Society of Testing and Materials, 2004), and (3) ASTM Standard Guide for Conducting Borehole Geophysical Logging Electromagnetic Induction - D6726 – 01 (American Society of Testing and Materials, 2007).

B6 Instrument/Equipment Testing, Inspection and Maintenance

All field equipment utilized for this groundwater sampling and borehole geophysics for this project will be properly maintained. For laboratory equipment, please see attachments 1, 2, and 3.

B7 Instrument/Equipment Calibration and Frequency

All field equipment utilized for groundwater sampling and borehole geophysics will be calibrated and standardized where appropriate. Multi-parameter field meters will be calibrated following standard USGS procedures (appendix A). For laboratory equipment, please see attachments 1, 2, and 3.

B8 Inspection/Acceptance of Supplies and Consumables

All materials used for sample collection will be inspected by the USGS PC/PM and field personnel.

B9 Data Management

See laboratory attachments 1, 2, and 3.

The USGS will maintain data obtained in association with this QAPP in electronic form on servers located in Fort Worth. These servers are backed up frequently to make sure data isn’t lost or destroyed. The documents provided by selected laboratories are typically in Microsoft Word, Microsoft Excel, or Adobe (PDF) formats. As described earlier a copy of all of the data and documents will be provided to EPA Region 6 in paper and electronic form. All logs will be collected in digital format and recorded in the proprietary format of the data acquisition equipment used. These proprietary data formats will be converted to and stored as Log American Standard Code for Information Interchange (ASCII) Standard (Canadian Well Logging Society, 2011) for tabular data and wellCAD version 4.4 and portable document format (PDF) for non-tabular data.

Data obtained by the USGS field personnel will be reviewed by the USGS PC/PM to assure accuracy, and that the data meets the quality criteria for that data type. Original field logbooks, copies of the COC forms sent to the USGS, and other field data will be screened by the PC/PM to ensure proper documentation and quality assurance.

The USGS PC/PM will be responsible for determining what data, if any; will be deleted from the data set. The USGS PC/PM will initially review any questions concerning analytical data. If a modification of the data originally reported is deemed necessary, documentation of the original data, the question concerning that data and the modified data along with the copies of the data change will be placed within the project file in paper format. Data will only be deleted from the data set if it is determined to be erroneous, or is found to have been collected in a manner that does not follow the QAPP guidelines causing poor data. The USGS PM will alert the EPA RPM to any abnormalities or apparent outliers.

In addition, USGS policy requires a data management plan for all project. The table below details the data management plan for this project.

Data Input – New Data [Field investigations to help support of background concentrations of uranium at the Homestake Mining Company Superfund Site near Milan, New Mexico]	
Description	Water-quality data and borehole geophysics data will be collected onsite and up gradient of site to help assess background uranium concentrations. Water-quality data will be collected by using passive samplers (5 wells) and collecting traditional groundwater samples (24 wells) by the use of a downhole submersible pump or existing infrastructure (withdrawal wells).
Data Management Resources	The budget for this project includes estimated time it will take to properly upload data to NWIS through the use of QWDX. Once the data are in place in NWIS, data sets used for data release and reports will be managed in Science Base. The budget has approximately 80 hours planned for data management and data release.
Data Product Formats	Data release through ScienceBase, fact sheet, and journal article.
Data Processing and Workflows	Most of the laboratories being used for this study are capable of transmitting samples results through the Water Quality Data Exchange (QWDX) which automatically uploads the data into NWIS. For laboratories without QWDX capabilities samples results will be manually entered by using a batch process.
Protocols and Standards	USGS staff will follow protocols and standards for sampling that are listed under the responsible parties sampling and analysis plans. Borehole geophysics data will be collected following standard ASTMs.
Quality Assurance Plan	A quality assurance plan will be developed for this project.
Formal Metadata Standard Used	Most of the water quality files will be in xml while the borehole geophysics will be in las.acii, welcad, and PDF
Volume Storage	200 MB

Backup	The NWIS is system is regularly backed up. Other data files used in the project will be placed in directories that are backed up regularly.
Repository: ScienceBase	ScienceBase is planned to be used as a final repository for this data.
Data Security and Access Control	A database manager will be assigned to the project to manage the data in ScienceBase. Other project personnel such as the project chief and manager will have access to the data, but main changes to the data will be managed by the data manager.
Contacts	Phil Harte (Project Chief), ptharte@usgs.gov, (603) 892-4170 Kent Becher (Project Manager), kdbecher@usgs.gov, (817) 253-0356 Victoria Stengel (Database Manager), vstengel@usgs.gov, (512) 927-3571

C1 Assessments and Response Actions

C1.1 Corrective Action

The USGS PC is responsible for implementing and tracking corrective action procedures as a result of audit findings. Records of audit findings and corrective actions are maintained by both the EPA and USGS QAO.

If audit findings and corrective actions cannot be resolved, then the authority and responsibility for terminating work is specified in the EPA Quality Management Plan and in agreements or contracts between participating organizations.

C2 Reports to Management

C2.1 Laboratory Data Reports

Laboratory data reports contain the results of all specified QC measures listed in section B5, including but not limited to field duplicates, laboratory blanks, laboratory control standards, calibrations, and matrix spikes. This information is reviewed by the USGS PC/PM and then compared to the pre-specified acceptance criteria to determine acceptability of data. This information is available for inspection by the EPA.

D1 Data Review, Validation, and Verification Requirements

All field and laboratory data will be reviewed and verified for integrity and continuity, reasonableness, and conformance to project requirements, and then validated against the project objectives and measurement performance specifications which are listed in Section A7. Only those data which are supported by appropriate QC data and meet the measurement performance specifications defined for this project will be considered acceptable, and will be reported to EPA.

D2 Validation and Verification Methods

Please see laboratory attachments 1, 2, and 3.

All field and laboratory data will be reviewed, verified and validated to ensure they conform to project specifications and meet the conditions of end use as described in Section A7 of this document.

Data review, verification, and validation will be performed using self-assessments and peer and management review as appropriate to the project task. The data review tasks to be performed by field and laboratory personnel are listed in the first two sections of Table D2, respectively. Potential errors are identified by examination of documentation and by manual (or computer-assisted) examination of corollary or unreasonable data. If a question arises or an error is identified, the manager of the task responsible for generating the data is contacted to resolve the issue. Issues which can be corrected are corrected and documented. If an issue cannot be corrected, the task manager consults with higher level project management to establish the appropriate course of action, or the data associated with the issue are rejected. Field and laboratory reviews, verifications, and validations are documented.

After the field and laboratory data are reviewed, another level of review is performed once the data are combined into a data set. This review step, as specified in Table D2, is performed by the USGS PC/PM. Data review, verification, and validation tasks to be performed on the data set include, but are not limited to, the confirmation of lab and field data review, evaluation of field QC results, additional evaluation of anomalies and outliers, analysis of sampling and analytical gaps, and confirmation that all parameters and sampling sites are included in the QAPP.

Any issues requiring corrective action must be addressed, and the potential impact of these issues on previously collected data will be assessed. After the data are reviewed and documented, the USGS PC/PM validates that the data meet the data-quality objectives of the project and are suitable for reporting to EPA.

Table D2: Data Review Tasks

Field Data Review	**Responsibility**
Field data reviewed for conformance with data collection, sample handling and chain of custody, analytical and QC requirements	USGS PC/PM
Field data calculated, reduced, and transcribed correctly	USGS PC/PM/BG/SG
Laboratory Data Review	

Field Data Review	Responsibility
Laboratory data reviewed for conformance with data collection, sample handling and chain of custody, analytical and QC requirements to include documentation, sample receipt, sample preparation, sample analysis, project and program QC results, and reporting	USGS PC/PM
Laboratory data calculated, reduced, and transcribed correctly	USGS PC/PM
Analytical data documentation evaluated for consistency, reasonableness and/or improper practices	USGS PC/PM
Analytical QC information evaluated to determine impact on individual analyses	USGS PC/PM
All laboratory samples analyzed for all parameters	USGS PC/PM
Data Set Review	
Confirmation that field and lab data have been reviewed	USGS PC/PM
Data set (to include field and laboratory data) evaluated for reasonableness and if corollary data agree	USGS PC/PM
Outliers confirmed and documented	USGS PC/PM
Field QC acceptable (e.g., field splits and trip, field and equipment blanks)	USGS PC/PM
Sampling and analytical data gaps checked and documented	USGS PC/PM
Verification and validation confirmed. Data meets conditions of end use and are reportable	USGS PC/PM

D3 Reconciliation with User Requirements

No decisions will be made by the USGS project team based on the data collected. These data will be used by EPA Region 6 for decision making through the Superfund Process.

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Appendix A- USGS Field Manual Groundwater Sampling Calibration Procedures and Specific Groundwater Sampling Methods

Please see USGS National Field Manual attachments. The work plan and QAPP sampling protocols will be followed along with the general USGS protocols outlined in the following documents:

Chapter 1: Preparation for Field Sampling
(http://water.usgs.gov/owq/FieldManual/chapter1/Ch1_contents.html)

Chapter 2: Selection of Equipment for Water Sampling
(http://water.usgs.gov/owq/FieldManual/Chapter2/Ch2_contents.html)

Chapter 3: Cleaning of Water Sampling Equipment
(http://water.usgs.gov/owq/FieldManual/chapter3/Ch3_contents.html)

Chapter 4: Collection of Water Samples
(http://water.usgs.gov/owq/FieldManual/chapter4/html/Ch4_contents.html)

Chapter 5: Processing of Water Samples
(http://water.usgs.gov/owq/FieldManual/chapter5/html/Ch5_contents.html)

Chapter 6.8 Use of Multiparameter Instrumentation for Routine Field Measurements
(http://water.usgs.gov/owq/FieldManual/Chapter6/6.8_contents.html)

Collection of He-4 samples http://water.usgs.gov/lab/dissolved-gas/sampling/index.html

Collection of Tritium (University of Utah)
http://www.noblegaslab.utah.edu/pdfs/tritium_collection.pdf

Dissolved gas sampling using copper tubing (University of Utah)
http://www.noblegaslab.utah.edu/pdfs/cu_tube_sampling.pdf

Collection of chlorofluorocarbons (University of Utah/USGS method)
http://www.noblegaslab.utah.edu/pdfs/USGS_CFC_sampling.pdf

Appendix B: USGS Groundwater Sampling Field Sheet

Attach ASR and WatList

USGS science for a changing world

U. S. GEOLOGICAL SURVEY GROUNDWATER QUALITY FIELD NOTES

NWIS RECORD NO ________________

Station No.______________________________ Station Name ____________________________________ Field ID ________________

Sample Date ____________________________ Mean Sample Time (watch) ______________ Time Datum ________ (eg. EST, EDT, UTC)

Sample Medium ______ Sample Type _____ Sample Purpose (71999) _____ Purpose of Site Visit (50280) _____ QC Samples Collected? Y N

Project No. ____ Project Name____

Sampling Team ______________________________________ Team Lead Signature ___________________________ Date ___________

FIELD MEASUREMENTS

Property	Parm Code	Method Code	Result	Units	Re-mark Code	Value Quali-fier	Null Value Qual-ifier	NWIS Result-Level Comments
Water Level (see p. 8 for codes and units)								
Flow Rate	00059			gal/min				
Sampling Depth	00003			ft				
Depth to top of sampling interval	72015			ft blw lsd				
Depth to bottom of sam-pling interval	72016			ft blw lsd				
Temperature, Air	00020	THM04 (Thermistor) THM05 (Thermometer)		˚C				
Temperature, Water	00010	THM01 (Thermistor) THM02 (Thermometer)		˚C				
Specific Conductance	00095	SC001 (Contacting Sensor)		µS/cm				
Dissolved Oxygen	00300	SPC1 (Spectrophotometer) LUMIN (Luminescent MEMBR (Amperometric)		mg/L				
Barometric Pressure	00025	BAROM (Barometer)		mm Hg				
pH	00400	PROBE (Electrode)		units				
ANC, unfiltered, incr. ANC, unfiltered, Gran	00419 29813	TT065 (Digital counter) TT066 (Buret) TT058 (Digital counter) TT059 (Buret)		mg/L				
Alkalinity, filtrd., incr. Alkalinity, filtrd., Gran	39086 29802	TT061 (Digital counter) TT062 (Buret) TT058 (Digital counter) TT059 (Buret)		mg/L				
Carbonate, filtrd., incr Carbonate, filtrd., Gran	00452 63788	ASM01(Digital counter) ASM02(Buret) ASM03(Digital counter) ASM04(Buret)		mg/L				
Bicarbonate, filtrd., incr. Bicarbonate, filtrd., Gran	00453 63786	ASM01(Digital counter) ASM02(Buret) ASM03(Digital counter) ASM04(Buret)		mg/L				
Hydroxide, filtrd., incr. Hydroxide, filtrd., Gran	71834 29800	ASM01(Digital counter) ASM02(Buret) ASM03(Digital counter) ASM04(Buret)		mg/L				
Turbidity [see attachment for codes]								
Redox potential (Eh)	63002			mvolts				
Hydrogen sulfide odor detected?	71875	SNIF1 (sniff test, acidified sample) SNIF2 (sniff test, non-acidified sample)	#	Yes No	M detect U non-detect			Sample acidified beforehand? yes no
Hydrogen sulfide, unfiltered, measured	99119	ISE01 (electrode) KIT01 (Chemetrics) KIT02 (Hach)		mg/L				

SAMPLING INFORMATION

Parameter	Pcode	Value	Information
Sampling Condition*	72006		Sampler/Pump Type (make/model): ____
Sampling Method*	82398		Pump/Sampler ID: ____________________________ Sampler Material: stainless steel pvc teflon other ________________________
Sampler Type*	84164		Tubing Material: teflon plastic tygon copper other______________________
***see p. 8 for values**			Filter type(s): capsule disc 142mm 25mm GFF membrane

COMPILED BY: ________________________ **CHECKED BY:** ___________________________ **LOGGED INTO NWIS BY:** ____________________________

Date________________________ **Date**_____________________________ **Date** ____________________________

FIELD ID ____________________ Station No. __________________

Aquifer name ____ Depth pump set at: ______________ft blw lsd msl mp

Sampling point description ____

GW Color: *brown gray blue green yellow other* ____

GW Clarity: *clear turbid muddy other* _______________________________ *Foaming: Yes No*

*Sand Present: Yes No If yes, color of sand: Black Brown Tan Yellow Gray Other*______________

GW Odor: Yes No *describe* ____

Sample in contact with: atmosphere oxygen nitrogen other ______

Weather: ***sky-*** clear partly cloudy cloudy ***precipitation-*** none light medium heavy snow sleet rain mist ________

wind- calm light breeze gusty windy est. wind speed __________ mph ***temperature-*** very cold cool warm hot

Observations:

Sample Comments (for NWIS; 300 characters max.):

LABORATORY INFORMATION *Sample Set ID _____*

SAMPLES COLLECTED:

Nutrients: ___WCA ___FCC ___FCA Major cations: ___FA ___RA Major anions: ___FU Trace elements: ___FA ___RA

Mercury: ___FAM ___RAM ___Wis. Hg Lab Lab pH/SC/ANC: ___RU

VOC: ______GCV (____ vials) Suspended solids: ___SUSO Turbidity: ___TBY Methylene Blue Active Substances: ___MBAS Color: ___RCB

Carbon: ___DOC ___TOC

Radon: ___RURCV (Radon sample collection time:______) Stable isotopes: ___FUS ___RUS

Radiochemicals: ___FUR ___RUR ___SUR ____FAR ___RAR ___BOD ___COD

Other:______________ (Lab______________) Other:______________ (Lab_____________) Other:______________ (Lab___________)

Other:______________ (Lab______________) Other:______________ (Lab_____________) Other:______________ (Lab___________)

Microbiology: ____ (Lab __________________)

Comments:
____

Date shipped:____________ Laboratory _____________________ Date shipped______________ Laboratory_________________

Date shipped:____________ Laboratory _____________________ Date shipped______________ Laboratory_________________

****Notify the NWQL in advance of shipment of potentially hazardous samples—phone 1-866-ASK-NWQL or email LabLogin@usgs.gov**

Comments:

GROUNDWATER LEVEL NOTES

Station No.______________________________ Field ID _______________

Station Name ____

Project No. ________________ Project Name_______________________

Measurement made by: ____

Signature ____________________________________ Date ____________

WELL___ SPRING___ MONITOR___ SUPPLY___ OTHER________________________

SUPPLY WELL PRIMARY USE: DOMESTIC__ PUBLIC SUPPLY__ IRRIGATION __ OTHER___________

Casing Material: _____________________ **Altitiude (land surface)** ________ **ft abv** MSL**(C16*)**

Measuring Point: ______ **ft abv blw** LSD**(C323*)** MSL**(C325*)**

Well Depth ________ ft abv blw LSD MSL MP

Casing/Well diameter (in)_______

Screened interval (ft): Top_________ Bottom __________ft abv blw LSD MSL MP

Sampling condition (72006) pumping (8) flowing (4) static (n/a)

[see QWDATA User Manual for additional fixed-value codes]

Water Level: _____________ ft blw LSD (72019) ft blw MP (61055)

ft abv MSL (NGVD 29) (62610) ft abv MSL (NAVD 88) (62611)

Comments/Notes(C267) (256 character limit):

____

____

____

____

Depth to Water and Well Depth	1ST	2ND	3RD (optional)
Time			
Hold (for DTW)			
⁻- Cut			
= DTW from MP (electric tape reading)			
– Measuring point (MP)			
= DTW from LSD			
Hold (for well depth)			
+ Length of tape leader			
= Well depth below MP			
– MP			
= Well depth below LSD			

WATER-LEVEL DATA FOR GWSI

DATE WATER LEVEL MEASURED (C235) __ __ - __ __ - __ __ __ __ TIME (C709) __ __ __ __

Month Day Year

TIME DATUM RELIABILITY CODE (C269)

E	K	T
estimated	known	transfered

TIME DATUM CODE (C402) __ __ __ __ __ __

WATER LEVEL __ __ __ __.__ __
(C237/241*/242)

EQUIPMENT IDENTIFIER (C249) (26 character limit).

__ __

WATER LEVEL TYPE CODE (C243)

L	M	S
below land surface	below meas. pt.	sea level

WATER LEVEL DATUM (C245)
(Mandatory if WL type=S)

NGVD 29	NAVD 88											
National Geodetic Vertical Datum Of	North American Vertical Datum Of 1988	Other (See GWSI manual for codes)

MP SEQUENCE NO. (C248) __ __ __
(Mandatory if WL type=M)

SITE STATUS FOR WATER LEVEL (C238)

A	B	C	D	E	F	G	H	I	J	M	N	O	P	R	S	T	V	W	X	Z
atmos. pressure	tide stage	ice	dry	recently flowing	flowing	nearby flowing	nearby recently	injector site	injector site	aquifer contact	measure-ment	obstruct-tion	pumping	recently pumped	nearby pumping	nearby recently	foreign sub-	well des-	affected by surface	other

METHOD OF WATER-LEVEL MEASUREMENT(C239)

A	B	C	D	E	F	G	H	L	M	N	O	P	R	S	T	V	Z
airline	analog	calibrated airline	differential gps	esti-mated	trans-ducer	pressure gage	calibrated pres. gage	geophysi-cal logs	manometer	non-rec. gage	observed	acoustic pulse	reported	steel tape	electric tape	calibrated elec. tape	other

WATER LEVEL ACCURACY (C276)

0	1	2	9
foot	tenth	hun-dreth	not to nearest foot

SOURCE OF WATER-LEVEL DATA (C244)

A	D	G	L	M	O	R	S	Z
other gov't	driller's log	geo-logist	geophysi-cal logs	memory	owner	other reported	reporting agency	other

PERSON MAKING MEASUREMENT (C246) (WATER-LEVEL PARTY) | | | | | |

MEASURING AGENCY (C247) (SOURCE) | | | | |

RECORD READY FOR WEB (C858)

Y	C	P	L
checked; ready for web display	not checked; no web display	proprietary; no web display	local use only; no web display

***Measuring Point Altitude (C325) or**
Measuring Point Height (C323) and Station Altitude (C16)
Are Required for Water Level (C241)

WELL PURGE LOG FIELD ID ____________________

Allowable Drawdown: _________ *ft* **Purge method:** STANDARD LOW-FLOW OTHER __________________________

START TIME:____________________ END TIME________________

Time	Water Level blw MP LSD ft	Draw-down ft	Well Yield gpm	Pumping Rate gpm	Water Temp °C	S C µs/cm	pH units	Dis-solved oxygen Mg/l	Turbidity _____ _____	________ ________	Comments [clarity, etc.]
											MEDIAN VALUES
											QUIESCENT PH
											FINAL FIELD MEASURE-

Well Volume (gal) = $V = 0.0408\ HD^2$ or **Well Volume =** $H \times F$

where:

V is volume of water in the well, in gallons
H is height of water column, in feet
D is inside Diameter of well, in inches
F is casing Volume Factor, in gallons per foot (see table)

H = Well depth - Static water level = _________ feet

Diameter, inside (*D*) = __________ inches

1 well volume (*V*) = __________ gallons

Parameter	Stability Criteria* (for more information see NFM Table 6.0-1)
pH	± 0.1 units (± 0.05 units if instrument display 2 or more digits to the right of the decimal) ± 0.3 if SC <~75µS/cm
Temperature (T)	± 0.2° C (thermistor)
Specific Conductivity (SC)	± 5%, of SC < 100 µS/cm ± 3%, for SC > 100 µS/cm
Dissolved Oxygen (DO)	± 0.2 mg/L
Turbidity (TU)	± 10%, for TU< 100: ambient TU is < 5 or most ground-water systems (visible TU > 5)

*allowable variation among 5 or more sequential field-measurement values

Purge Volume = (*n*)(*V*) = __________ **gallons [Actual =**_________ **gal]**

where:

n is number of well volumes to be removed during purging
V is volume of water in the well, in gallons

Q = estimated pumping rate = _______ gallons per minute

Approximate purge time = (purge volume)/*Q* = ________ minutes

	VOLUME FACTORS												
DIAMETER (in.)	1.0	1.5	2.0	3.0	4.0	4.5	5.0	6.0	8.0	10.0	12.0	24.0	36.0
CASING VOL. FACTOR (F)	0.04	0.09	0.16	0.37	0.65	0.83	1.02	1.47	2.61	4.08	5.88	23.5	52.9

Screened/Open Interval: TOP _________.____ ft blw LSD MSL

Bottom _________.____ ft blw LSD MSL

Depth to Top of Sampling Interval _______.____ft blw LSD MSL

Depth to Bottom of Sampling Interval _______._____ ft blw LSD MSL

Depth to set pump from MP (all units in feet except where noted) :	
Distance to top of screen from LSD	
+ MP (- if MP below LS)	
– (7 to 10 x diameter (inches) of the well) [convert to feet]	
= Depth to pump intake from MP	
Depth to pump from LSD (all units in feet) :	
– MP	
= Depth pump set from LSD MSL	

Notes/Calculations:

Calibrated by:_________________________ Location:______________________ Station No. _________________
Date:________________ Time:_____________

METER CALIBRATIONS and FIELD MEASUREMENTS

TEMPERATURE Meter make/model ________________ S/N ______________ Thermistor S/N ____________ Thermometer ID ________

Calibration criteria: ± 0.2 °C for thermistors

Local Meter

Lab Tested against NIST Thermometer/Thermistor? Y N Date: __________________ ±___________ °C

Measurement Location: SINGLE POINT AT _______ ft DEEP STREAMSIDE _____ FT FROM LEFT RIGHT BANK VERTICAL AVG/MEDIAN OF _____ PTS

Field Readings # 1 ______ #2 ______ #3 ______ #4 ______ #5 ______ **MEDIAN**:______ **ºC** Method Code ______ Remark ___ ___ Qualifier __

SPECIFIC CONDUCTANCE Meter MAKE/MODEL _________________ S/N ______________ Sensor ID _________________

Sample: CONE SPLITTER CHURN SPLITTER SINGLE POINT AT ______ ft DEEP VERTICAL AVG. OF _______ POINTS

LOCAL METER ID:_______________ AUTO TEMP COMPENSATED METER? Y N CORRECTION FACTOR APPLIES? Y N CORRECTION FACTOR:______

Std Value µS/cm	Std Temp	SC Before Adj.	SC After Adj.	Vendor Lot No.	NWIS Parameter Code (see last page)	NWIS* Lot No.	Expiration Date

Calibration Criteria: ± 5 % for SC ≤100 µS/cm or 3% for SC >100 µS/cm ***NWIS Lot Numbers are available at: http://wwwnwql.cr.usgs.gov/qas.shtml?ConductivityStds_home**

Field readings #1_____ #2_____ #3_____ #4_____ #5 _____ **MEDIAN:** ______ **µS/cm** Method Code ______ Remark ___ ___ Qualifier ___ ___

DISSOLVED OXYGEN Meter MAKE/MODEL ________________________________ S/N ______________________

Sensor Type: Amperometric Luminescent Spectrophotometer Sensor ID ___________________________Local Meter ID_____________

Calibration Method: Air-Saturated Water Water-Saturated Air

Sample: SINGLE POINT AT _______ ft DEEP VERTICAL AVG. OF _____ POINTS BOD BOTTLE OTHER_____________ Stirrer Used? Y N

Calibration Temperature ºC	Barometric Pressure mm Hg	DO Table Reading mg/L	Salinity Correc-tion Factor	DO Before Adjustment mg/L	DO After Adjust-ment mg/L

Zero DO Check _________mg/L Adj. to _________ mg/L Date: ______________

Thermister Check? Y N Date_________

Barometer Calibrated? N Y Date: _______________ Time: _______

Phase Degrees/Slope/Gain/Scale Factor (100%)_______________(Zero)________

Calibration Criteria: ± 0.2 mg/L **DO saturation** ______ **%**

Field readings #1______ #2_____ #3_____ #4_____ #5 _____ **MEDIAN:** ______ **mg/L** Method Code ______ Remark ___ ___ Qualifier ____

pH Meter MAKE/MODEL ___________________ S/N ________________ Electrode ID ______________ Type: GEL LIQUID OTHER ________

Sample: FILTERED UNFILTERED CONE CHURN SPLITTER SINGLE POINT AT _______ ft DEEP VERTICAL AVG. OF ____ POINTS

TEMPERATURE CORRECTION FACTORS APPLIED TO BUFFERS? Y N

pH BUFFER	BUFFER TEMP	THEO-RETICAL pH FROM TABLE	pH BEFORE ADJ.	pH AFTER ADJ.	SLOPE	MILLI-VOLTS
pH 7						
pH ___						
CHECK pH ___						

pH Buffer	Vendor Lot No.	NWIS* Lot No.	Expiration Date
pH 7 (99173)			
pH 10 (99171)			
pH 4 (99172)			

Calibration Criteria: ± 0.1 pH units, ± 0.3 if SC <75us/cm ***NWIS Lot Numbers are available at: http://wwwnwql.cr.usgs.gov/qas.shtml?Buffers_home**
Millivolts: pH 7 –10 to +10 , pH4 +165 to +195 mV, pH 10 –165 to –195 mV
Slope Acceptance Criteria: 95% to 102%

Field Readings #1________ #2________ #3________ #4________ #5 ________ **MEDIAN:** ______ **Units** Remark ___ ___ Qualifier ___

FIELD ID ____________________

TURBIDITY Meter make/model ____________________ S/N ________________ Type: turbidimeter submersible spectrophotometer

Sample: pump discharge line flow-thru chamber single point at _______ ft blw LSD MSL MP Sensor ID ________________

Sample: Collection Time: ________ Measurement Time: ________ Measurement: In-situ/On-site Vehicle Office lab NWQL Other __________

Sample diluted? Y N Vol. of dilution water ________ mL Sample volume ________ mL

	Lot Number or Date Prepared	Expiration Date	Concentration ________ (units)	Calibration Temperature °C	Initial instrument reading	Reading after adjustment
Stock Turbidity Standard						
Zero Standard (*DIW*)						
Standard 1						
Standard 2						
Standard 3						

TURBIDITY VALUE = ***A*** x (***B***+***C***) / ***C***

where:

A= TURBIDITY VALUE IN DILUTED SAMPLE
B= VOLUME OF DILUTION WATER, mL
C= SAMPLE VOLUME, mL

Calibration Criteria:

$\leq$ 100 Turbidity units	± 0.5 turbidity units or ± 5% of the measured Value, whichever Is greater
> 100 Turbidity units	± 10%

Field Readings #1 _________ #2 __________ #3 __________ #4 __________ #5 _________

MEDIAN _______ **Parameter Code** ________ FNU NTU NTRU FNMU FNRU FAU FBU AU METHOD CODE __________ Remark ___ ___ Qualifier ___ ___

QUALITY-CONTROL INFORMATION

PRESERVATIVE, BLANK WATER and SPIKE NWIS LOT NUMBERS

NWIS lot numbers are available at: http://wwwnwql.cr.usgs.gov/qas.shtml?nfssqa_certificates

Description	Parameter Code	ExpirationDate	Manufacturer Lot Number	NWIS Lot Number
4.5N H_2SO_4 (NUTRIENTS AND DOC)	99156			
7.5N-7.7N HNO_3(METALS&CATIONS)	99159			
6N HCl (Mercury)	99158			
1:1 HCl (VOC)	99157			
18N H_2SO_4 (COD and Phenol)	99155			
Inorganic Blank Water	99200			
Organic Blank Water	99202			
VOC/Organic Blank Water	99204			
Spike	99104			

Filter Lot Numbers

Filter descriptions with parameter codes require NWIS LOT NUMBERS available at http://wwwnwql.cr.usgs.gov/qas.shtml?filters_home

Filter Type	Pore Size (microns)	Parameter Code	Manufacturer's Lot Number	NWIS Lot Number
Capsule	0.45	**99206**		
Disc	0.45	**99206**		
142 mm GFF (organics)	0.70			
Syringe (organics)	0.70	**99207**		
25 mm GFF (organic carbon)	0.70			
142 mm membrane (inorganics)	0.45			

QC SAMPLES

Sample Type	NWIS Record No.	Sample Type	NWIS Record No.	Sample Type	NWIS Record No.
Equip Blank _____	_____________	Sequential _____	______________	Trip Blank ________	______________
Field Blank _____	_____________	Spike _____	______________	Other ___________	______________
Split _____	_____________	Concurrent _____	______________	Other ___________	______________

NWQL Schedules/lab codes (QC Samples) __________ _________ _________ _________ _________ _________

ALKALINITY/ANC

BEGINNING H_2O TEMP. _________ °C
Specific Conductance___________µS/cm

BEGINNING H_2O TEMP. _________ °C
Specific Conductance___________µS/cm

pH	ΔpH	Vol acid DC or mL	ΔVol acid DC or mL	ΔpH / ΔVol acid	pH	ΔpH	Vol acid DC or mL	ΔVol acid DC or mL	ΔpH / ΔVol acid

End H_2O temp. ________ °C
Specific Conductance___________µS/cm

End H_2O temp. ________ °C
Specific Conductance____________µS/cm

FIRST TITRATION

Date ______________ Initials _______________

Begin time____________ End time____________

Alkalinity/ANC ______________ mg/L as $CaCO_3$

Bicarbonate ________________mg/L as HCO_3^-

Carbonate __________________mg/L as CO_3^{2-}

Hydroxide __________________mg/L as OH^-

Acid: 1.6N 0.16N 0.01639N Other:______

Acid Lot No. ________Expiration Date _________

Correction factor: 1.00 1.01

Acid Delivery: Digital Counter Buret

Sample Volume: _______mL Filtered Unfiltered

Method: Inflection Point Gran

SECOND TITRATION

Date ______________ Initials _______________

Begin time____________ End time____________

Alkalinity/ANC ______________ mg/L as $CaCO_3$

Bicarbonate ________________mg/L as HCO_3^-

Carbonate __________________mg/L as CO_3^{2-}

Hydroxide __________________mg/L as OH^-

Acid: 1.6N 0.16N 0.01639N Other:______

Acid Lot No. ________Expiration Date _________

Correction factor: 1.00 1.01

Acid Delivery: Digital Counter Buret

Sample Volume: _______mL Filtered Unfiltered

Method: Inflection Point Gran

Use the Alkalinity Calculator at: **http://or.water.usgs.gov/alk** or PCFF

Alkalinity/ANC pH Meter Calibration		
Meter make/model:	S/N	
Calibration Location:		
Electrode No.		
Electrode type GEL LIQUID		
	pH 7	**pH ____**
BUFFER TEMPERATURE		
THEORETICAL FROM TABLE		
pH BEFORE ADJUSTMENT		
pH AFTER ADJUSTMENT		
SLOPE		
MILLIVOLTS		
MANUFACTURER LOT NUMBER		
NWIS LOT NUMBER		

Field titration by:_________________

Checked by:______________

REFERENCE LIST FOR CODES USED ON THIS FORM

Sample Medium Codes
WG Regular Ground water
WGQ Quality-control sample (Replicate or Spike)
OAQ Blank

The complete list of fixed-value codes can be found online at: http://nwis.usgs.gov/nwisdocs4_10/gw/QW-AppxB.pdf

Time Datum Codes

Time Zone	Std Time Code	UTC Offset (hours)	Daylight Time Code	UTC Offset (hours)
Hawaii-Aleutian	HST	-10	HDT	-9
Alaska	AKST	-9	AKDT	-8
Pacific	PST	-8	PDT	-7
Mountain	MST	-7	MDT	-6
Central	CST	-6	CDT	-5
Eastern	EST	-5	EDT	-4
Atlantic	AST	-4	ADT	-3

Value Qualifiers
e see field comment
f sample field preparation problem
k counts outside the acceptable range

71999 Sample purpose
10 Routine
15 NAWQA
50 GW Network
110 Seepage Study
120 Irrigation Effects
130 Recharge
140 Injection

Sample Type Code
9 Regular
7 Replicate
2 Blank
1 Spike
3 Reference
B Other QA
H Composite

Null-value Qualifiers
e required equipment not functional or available
f sample discarded; improper filter used
o insufficient amount of sample
p sample discarded; improper preservation
q sample discarded; holding time exceeded
r sample ruined in preparation

50280 Purpose of site visit
2001 Primary (primary samples should not exist for a site for more than one date per HIP, and the primary sampling date generally has the highest number of NAWQA analytes)
2002 Supplemental (to fill in missing schedules not sampled or lost)
2003 Temporal characterization (for previously sampled schedules; includes LIP and seasonal samples)
2004 Resample (to verify questionable concentrations in primary sample)
2098 Ground-water quality control
2099 Other (ground-water related samples with medium code other than "6", such as soil samples or core material)

82398 Sampling method
4010 Thief sampler
4020 Open-top bailer
4025 Double-valve bailer
4030 Suction pump
4040 Submersible pump
4045 Submersible multiple impeller (turbine) pump
4050 Squeeze pump
4060 Gas reciprocating pump
4070 Gas lift
4080 Peristaltic pump
4090 Jet pump
4100 Flowing well
4110 Resin trap collector
8010 Other

84164 Sampler type
4010 Thief Sampler
4020 Open-top Bailer
4025 Double-valve Bailer
4030 Suction Pump
4035 Submersible Centrifugal Pump
4040 Submersible Positive-pressure Pump
4041 Submersible Helical Rotor Pump
4045 Submersible Gear Pump
4050 Bladder Pump
4060 Gas Reciprocating Pump
4070 Gas Lift
4075 Submersible Piston Pump
4080 Peristaltic Pump
4090 Jet pump
4095 Line-Shaft Turbine Pump
4100 Flowing Well
8010 Other

72006 Sampling Condition
0.01 The site was dry (no water level is recorded)
0.02 The site had been flowing recently
0.03 The site was flowing, head could not be measured
0.04 A nearby site that taps the Aquifer was flowing
0.05 Nearby site tapping same Aquifer had been flowing recently
0.06 Injector site
0.07 Injector site monitor
0.08 Measurement discontinued
0.09 Obstruction encountered in well above water surface
0.10 The site was being pumped
0.11 The site had been pumped recently
0.12 Nearby site tapping the same Aquifer was being pumped
0.13 Nearby site tapping the Same Aquifer was pumped recently
0.14 Foreign substance present on the surface of the water
0.16 Water level affected by stage in nearby site
0.17 Other conditions affecting the measured water level
2 Undesignated
4 Flowing
6 Flowing on gas lift
8 Pumping
10 Open hole
18 Producing
19 Circulating
22 Lifting
23 Flowing to Pit
24 Water Flooding
25 Jetting
30 Seeping
31 Nearby well pumping
32 Nearby well taking water
33 Well taking water

71875 Hydrogen Sulfide Odor
Value
none entered (null)

Remark Code	Method Code
M detect	U un-acidified sample
U non-detect	V acidified sample

00003 Sampling depth, ft
78890 Sampling depth, ft blw msl
00059 Flow rate, instantaneous, gallons per minute
72004 Pump or flow period prior to sampling, minutes

Water Level
61055 Water level, depth below measuring point, feet
62610 Ground-water level above NGVD 1929, feet
62611 Ground-water level above NAVD 1988, feet
72019 Depth to water level, feet below land surface

NWIS Lot Number Parameter Codes* for Conductance Standards

Parameter Code	Standard Value µS/cm, KCl
99160	50
99161	100
99162	250
99163	500
99164	750
99165	1000
99166	2500
99167	5000
99168	10,000
99169	25,000
99170	50,000

Dissolved Oxygen

AZIDE	Azide-modified Winkler	INDIGO	Sepctrophotometer, indigo carmine
INDKT	Field Kit, ndigo carmine, visual	LUMIN	Luminscence sensor
MEMB2	Amperometric, Membrane (DODEC)	MEMBR	Ampermetric, Membrand electrode
RHODA	Field Kit, Rhodazine-D, visual	SPC10	Spectrophotometer, Rhodazine-D

Parameter and method codes for field measurements: http://water.usgs.gov/usgs/owq/Forms.html

***NWIS Lot numbers and Certificates of Analysis:** http://wwwnwql.cr.usgs.gov/qas.shtml?nfssqa_certificates

National Field Manual: http://water.usgs.gov/owq/FieldManual/

Alkalinity Calculator, Alkalinity/ANC parameter and method codes: http://or.water.usgs.gov/alk/reporting.html

Appendix C: USGS Borehole Geophysics Field Sheets

USGS science for a changing world

U. S. GEOLOGICAL SURVEY GEOPHYSICAL LOGGING NOTES

VER: 11.2007

Station No.______________________________ Station Name ____________________________ State Well ID _______________

Start Date __________________________ End Date ____________________ Time Datum _______ (eg. CST, CDT, UTC)

Project No. ______________ Project Name______________________ QW Samples Collected? Y N Time for QW samples______

Logger ___________________________________ Observer_________________________________

Latitude_________________ Longitude ________________ Elevation_____ Topographic Map Quad name ______________

Comments:

LOGGING INFORMATION

Logs Run:

Acoustic Televiewer	(AT) ___	Combination Tools	
Optical Televiewer	(OT) ___	Gamma, L/S Norm.,SP, Fl Res, Temp	(ZE) ___
Video	(OV) ___	Gamma, Fluid Resistivity, Temperature	(ZF) ___
Acoustic Caliper	(CA) ___	Gamma, Electromagnetic Induction	(ZI) ___
Caliper, three arm	(CT) ___	Long/Short Normal Resistivity	(ZR) ___
Spontaneous Potential	(EP) ___	Fluid Resistivity, Temperature	(ZT) ___
Electromagnetic Induction	(MI) ___	EM Flowmeter, Fluid Res., Temperature	(ZM) ___
EM Dual Induction	(MD) ___	Caliper (three arm), CCL	(ZW)___
Fluid Conductance	(FC) ___	Other _________________________	
Fluid Resistivity	(FR) ___		
Heat Pulse Flowmeter	(FH) ___	Heat Pulse Flowmeter (pumping conditions)	(FH) ___pumping
Electromagnetic Flowmeter	(FE) ___	EM Flowmeter (pumping conditions)	(FE) ___ pumping

WATER-LEVEL DATA FOR GWSI

DATE WATER LEVEL MEASURED (C235) __ __ - __ __ - __ __ __ __ (Month Day Year) TIME (C709) __ __ __ __

WATER LEVEL TYPE CODE (C243): L (below land surface) M (below meas. pt.) S (sea level)

WATER LEVEL (C237/241/242) __ __ __ __.__ __

MP SEQUENCE NO. (C248) __ __ __ (Mandatory if WL type=M)

WATER LEVEL DATUM (C245) (Mandatory if WL type=S): NGVD 29 (National Geodetic Vertical Datum 0f 1929) NAVD 88 (North American Vertical Datum 0f 1988) | | | | | | | | | (Other (See GWSI manual for codes))

SITE STATUS FOR WATER LEVEL (C238):

A	B	C	D	E	F	G	H	I	J	M	N	O	P	R	S	T	V	W	X
atmos. pressure	tide stage	ice	dry	recently flowing	flowing	nearby flowing	nearby recently flowing	injector site	injector site monitor	plugged	measure-ment discontinued	obstruct-tion	pumping	recently pumped	nearby pumping	nearby recently pumped	foreign sub-stance	well des-troyed	affected by surface water

other

METHOD OF WATER-LEVEL MEASUREMENT(C239):

A	B	C	E	F	G	H	L	M	N	O	R	S	T	V
airline	analog	calibrated airline	esti-mated	trans-ducer	pressure gage	calibrated pres. gage	geophysi-cal logs	manometer	non-rec. gage	observed	reported	steel tape	electric tape	calibrated elec. tape

other

WATER LEVEL ACCURACY (C276): 0 (foot) 1 (tenth) 2 (hun-dreth) 9 (not to nearest foot)

SOURCE OF WATER-LEVEL DATA (C244):

A	D	G	L	M	O	R	S
other gov't	driller's log	geol-ist	geophysi-cal logs	memory	owner	other reported	reporting agency

other

PERSON MAKING MEASUREMENT (C246) (WATER-LEVEL PARTY) | | | | | |

MEASURING AGENCY (C247) (SOURCE) | | | | |

RECORD READY FOR WEB (C858): Y (checked; ready for web display) C (not checked; no web display) P (proprietary; no web display) (local use only; no web display)

Aquifer name ____ Depth pump set at: ____________ft blw LSD MSL

Weather : ***SKY-*** CLEAR PARTLY CLOUDY CLOUDY ***PRECIPITATION-*** NONE LIGHT MEDIUM HEAVY SNOW SLEET RAIN MIST ________

WIND- CALM LIGHT BREEZE GUSTY WINDY EST. WIND SPEED _________ MPH ***TEMPERATURE-*** VERY COLD COOL WARM HOT

OBSERVATIONS:

COMPILED BY :___________ DATE ________ CHECKED BY :___________ DATE _______ LOGGED INTO GWSI BY: __________ DATE ________

LOG PROCESSED BY : ___________ FILENAME :____________ LAS FILE CREATED BY :____________ LAS FILENAME :____________

1

Well and Water Level Information

Depth to Water and Well Depth	1ST	2ND	3RD (optional)
Time			
Hold (for DTW)			
⌐⌐ - wet/eline correction			
= DTW from MP			
– Measuring point (MP)			
= DTW from LSD			
Hold (for well depth)			
+ Length of tape leader			
= Well depth below MP			
– MP			
= Well depth below LSD			

WELL___ SPRING___ MONITOR___ SUPPLY___
OTHER___________________

SUPPLY WELL PRIMARY USE: DOMESTIC__ PUBLIC SUPPLY__ IRRIGATION __
OTHER________

Casing Material: ___________ Casing Diameter ___________

Depth to bottom of casing_________

Reported Depth __________ ft abv blw LSD MSL MP

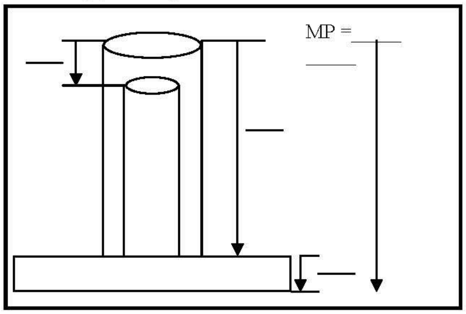
Actual Depth ___________ft abv blw lsd msl mp

Logging condition pumping (8) flowing (4) static (n/a)

[see reference list for additional fixed-value codes]

Comments:

Measuring point diagram



Description of log measuring point

Set to MP Set to LSD
Altitude of log measuring point __________
Magnetic Declination __________
Log Orientation __________
Depth Error after logging __________
Hydrologic Conditions __________

Remarks:

Time	Logging Tool	Model	Serial Number	Logging Direction	Water Temp	Calibration Date	Standard	Response CPS		Comments [clarity, etc.]

<u>Flowmeter Stations:</u> Ambient

Manufacturer: ______________ Model:___________ SN: _________

Start time:______ Warm up time:________ Depth for warm up time:_______ End time:_______

Display depth	Sensor depth	Upward flow (+)	Downward flow (-)	Indicated depth	Sensor depth	Upward flow (+)	Downward flow (-)

<u>Flowmeter Stations:</u> Pumping/Flowing Manufacturer: _____________ Model:__________ SN: ________

Start time:_____ Warm up time:_______ Depth for warm up time:______ End time:______

Display depth	Sensor depth	Upward flow (+)	Down-ward flow (-)	Water Level	Pump Rate (gpm)	STD L/min	Indicat-ed depth	Sensor depth	Upward flow (+)	Down-ward flow (-)	Pump Rate (gpm)

Time	Water Level blw MP LSD	Draw-down ft	Well Yield gpm	Pumping Rate gpm	Water Temp °C	Conduc-tivity µs/cm	pH units	Dis-solved oxygen	Turbidity ______ ______	Comments [clarity, etc.]
										MEDIAN VALUES
										QUIESCENT pH
										FINAL FIELD MEASUREMENTS

Well Volume (gal) = *V* = 0.0408 *HD*² or **Well Volume = *H* x *F***

where:
- ***V*** is volume of water in the well, in gallons
- ***H*** is height of water column, in feet
- ***D*** is inside Diameter of well, in inches
- ***F*** is casing Volume Factor (see table)

H = Well depth - Static water level = __________ feet

Diameter, inside (***D***) = ___________ inches

1 well volume (***V***) = ___________ gallons

Parameter	Stability Criteria*
pH	± 0.1 units (± 0.05 units if instrument display 2 or more digits to the right of the decimal)
Temperature (T)	± 0.2° C (thermistor)
Specific Conductivity (SC)	± 5%, of SC < 100 µS/cm ± 3%, for SC > 100 µS/cm
Dissolved Oxygen (DO)	± 0.3 mg/L
Turbidity (TU)	± 10%, for TU< 100: ambient TU is < 5 or most ground-water systems (visible TU > 5)

*allowable variation between 5 or more sequential field-measurement values

Purge Volume = (*n*)(*V*) = ___________ gallons [Actual =__________ gal]

where:
- ***n*** is number of well volumes to be removed during purging
- ***V*** is volume of water in the well, in gallons

Q = estimated pumping rate = _______ gallons per minute

Approximate purge time = (purge volume)/***Q*** = ________ minutes

	VOLUME FACTORS											
DIAMETER (in.)	1.0	1.5	2.0	3.0	4.0	4.5	5.0	6.0	8.0	10.0	12.0	24.0	36.0
CASING VOL.	0.04	0.09	0.16	0.37	0.65	0.83	1.02	1.47	2.61	4.08	5.88	23.5	52.9

Screened/Open Interval: TOP _________.____ ft blw LSD MSL

Bottom __________.____ ft blw LSD MSL

Depth to Top of Sampling Interval _______.____ft blw LSD MSL

Depth to Bottom of Sampling Interval _______._____ ft blw LSD MSL

Depth to set pump from MP (all units in feet) :	
Distance to top of screen from LSD	
+ MP	
− (7 to 10 x diameter (ft) of the well)	
= Depth to pump intake from MP	
Depth to pump from LSD (all units in feet) :	
− MP	
= Depth pump set from LSD MSL	

Notes/Calculations:

LOG CATEGORY	CODE	LOG TYPE
ACOUSTIC	AV	Acoustic Velocity
	AW	Acoustic Waveform
	AT	Acoustic Televiewer
CALIPER	CP	Caliper
	CS	Caliper, Single Arm
	CT	Caliper, Three Arm
	CM	Caliper, Multiple Arm
	CA	Caliper, Acoustic
ELECTRIC	ER	Single-point Resistance
	EP	Spontaneous Potential
	EL	Long-normal Resistivity
	ES	Short-normal Resistivity
	EF	Focused Resistivity
	ET	Lateral Resistivity
	EN	Microresistivity
	EC	Microresistivity, Focused
	EO	Microresistivity, Lateral
	ED	Dipmeter
ELECTROMAGNETIC	MM	Magnetic
	MS	Magnetic Susceptibility
	MI	Electromagnetic Induction
	MD	Electromagnetic Dual Induction
	MR	Radar Reflection Image
	MV	Radar Direct-wave Velocity
	MA	Radar Direct-wave Amplitude
FLUID	FC	Fluid Conductivity
	FR	Fluid Resistivity
	FT	Fluid Temperature
	FF	Fluid Differential Temperature
	FV	Fluid Velocity
	FS	Spinner Flowmeter
	FH	Heat-pulse Flowmeter
	FE	Electromagnetic Flowmeter
	FD	Doppler Flowmeter
	FA	Radioactive Tracer
	FY	Dye tracer
	FB	Brine Tracer
NUCLEAR	NG	Gamma
	NS	Spectral Gamma
	NA	Gamma-gamma
	NN	Neutron
	NT	Neutron Activation
	NM	Nuclear Magnetic Resonance
OPTICAL	OV	Video
	OF	Fisheye Video
	OS	Sidewall Video
	OT	Optical Televiewer
WELL CONSTRUCTION	WC	Casing Collar
	WD	Borehole Deviation
COMBINATION	ZF	Gamma, Fluid Resistivity, and Temperature
	ZI	Gamma and EM Induction
	ZR	Long/short Normal Resistivity
	ZT	Fluid Resistivity and Temperature
	ZM	EM FLowmeter, Fluid Resistivity, and Temperature
	ZN	Long/short Normal Resistivity and Spontaneous Potential
	ZP	Single-point Resistance and Spontaneous Potential
	ZE	Gamma, Long/short Normal Resistivity, Spontaneous Potential, Single-point Resistance, Fluid Resistivity, and Temperature

Appendix D: USGS Passive Sampling Field Sheet

Passive Sampler Deployment Field Sheet-page 1

Location ____________________

Weather conditions ____________________ Temperature (degrees C) ____________

Local well name ____________ USGS SID# ____________________

Measurement point (MP) ____________________ [eg. TOP OF PIPE, ETC.]

Well construction material ____________________ [EG. PVC, Steel]

Well Diameter ____________________ [Units]

Units of Measurement below if not noted [Circle: M-meters; Ft-feet; other_______]

2 MP Distance Relative to Land Surface ____________________

3 Sounding Depth of Well from MP ____________________

4 Depth to Water Level (DTW) from MP ____________________

5 **Date/Time of water level** ____________________

6 Reported Well Depth from Datum ____________________ [Specify Datum; eg. Land surface]

7 Reported Open Interval from Datum ____________________ [Specify Datum; eg. Land surface]

8 Reported Well Depth from MP ____________________ [Same if datum=MP]

9 Reported Open Interval from MP ____________________ [Same if datum=MP]

10 Corrected Well Depth (MP) from Sounding ____________________ [Adjusted per sounding (3)]
(If sounding depth = reported depth from MP then no correction)

11 Corrected Open Interval (MP) from Sounding ____________________ [Adjusted per sounding (3)]
(If sounding depth = reported depth from MP then no correction)

12 Corrected Saturated Column Interval from MP ____________________ [Adjusted per sounding (3) and DTW(4)]

13 Corrected Saturated Column Distance above Sounding Depth ____________________ [Adjusted per sounding (3) and DTW(4)]

14 Corrected Saturated Open Interval above Sounding Depth ____________ [Adjusted per sounding (3) and DTW(4)]

Deployment Locations of Samplers (List range of sampler locations above sounding depth) ____________

Other Notes

Passive Sampler Deployment Field Sheet-page 2

Well__________

Type of sampler ______________________ [PDB,NSPS,RPP,RCDM, ETC.]

Length of sampler ______________________ [Units]

Diameter of sampler ______________________ [Units]

Medium Type ______________________ [D.I. water, other]

Medium Blank Sample Date ______________________

Sampler housing ______________________ [eg. polyethene mil type, mesh type]

Deployment Date/Time ______________________

Number of Samplers Deployed ______________________

Suspension information ______________________ [eg. line, weight, material]

Spacing distance of samplers (from sampler midpoint) ______________________

s#	First Sampler (ID) and location relative to sounding depth (midpoint)	______________
s#	Next Sampler (I.D.) and location relative to sounding depth (midpoint-midpoint)	______________
s#	Next Sampler (I.D.) and location relative to sounding depth (midpoint-midpoint)	______________
s#	Next Sampler (I.D.) and location relative to sounding depth (midpoint-midpoint)	______________
s#	Next Sampler (I.D.) and location relative to sounding depth (midpoint-midpoint)	______________
s#	Next Sampler (I.D.) and location relative to sounding depth (midpoint-midpoint)	______________
s#	Next Sampler (I.D.) and location relative to sounding depth (midpoint-midpoint)	______________
s#	Next Sampler (I.D.) and location relative to sounding depth (midpoint-midpoint)	______________
s#	Next Sampler (I.D.) and location relative to sounding depth (midpoint-midpoint)	______________
s#	Next Sampler (I.D.) and location relative to sounding depth (midpoint-midpoint)	______________
s#	Next Sampler (I.D.) and location relative to sounding depth (midpoint-midpoint)	______________
s#	Last Sampler (I.D.) and location relative to sounding depth (midpoint-midpoint)	______________

WELL Stickup

casing

Fm

open interval

Sketch loc. of samplers

Comments:

Attach Pictures-Page 3

Well I.D. ______________________